SCIENTIFIC AMERICAN SUPPLEMENT. No 1446

Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1903, by Munn & Co.

Scientific American, established 1845.
Scientific American Supplement, Vol. LVI. No. 1446.

NEW YORK, SEPTEMBER 19, 1903.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

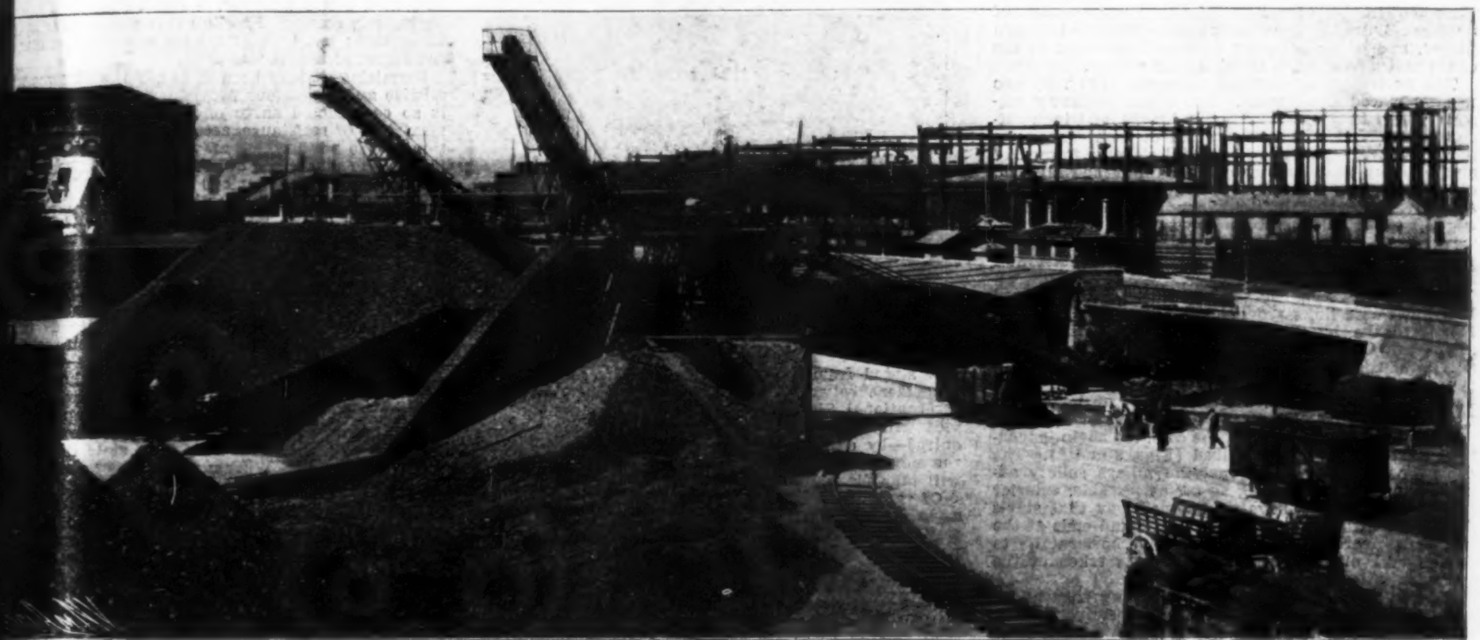


FIG. 8.—GENERAL VIEW OF LA VILLETTE YARDS, SHOWING CONVEYORS.

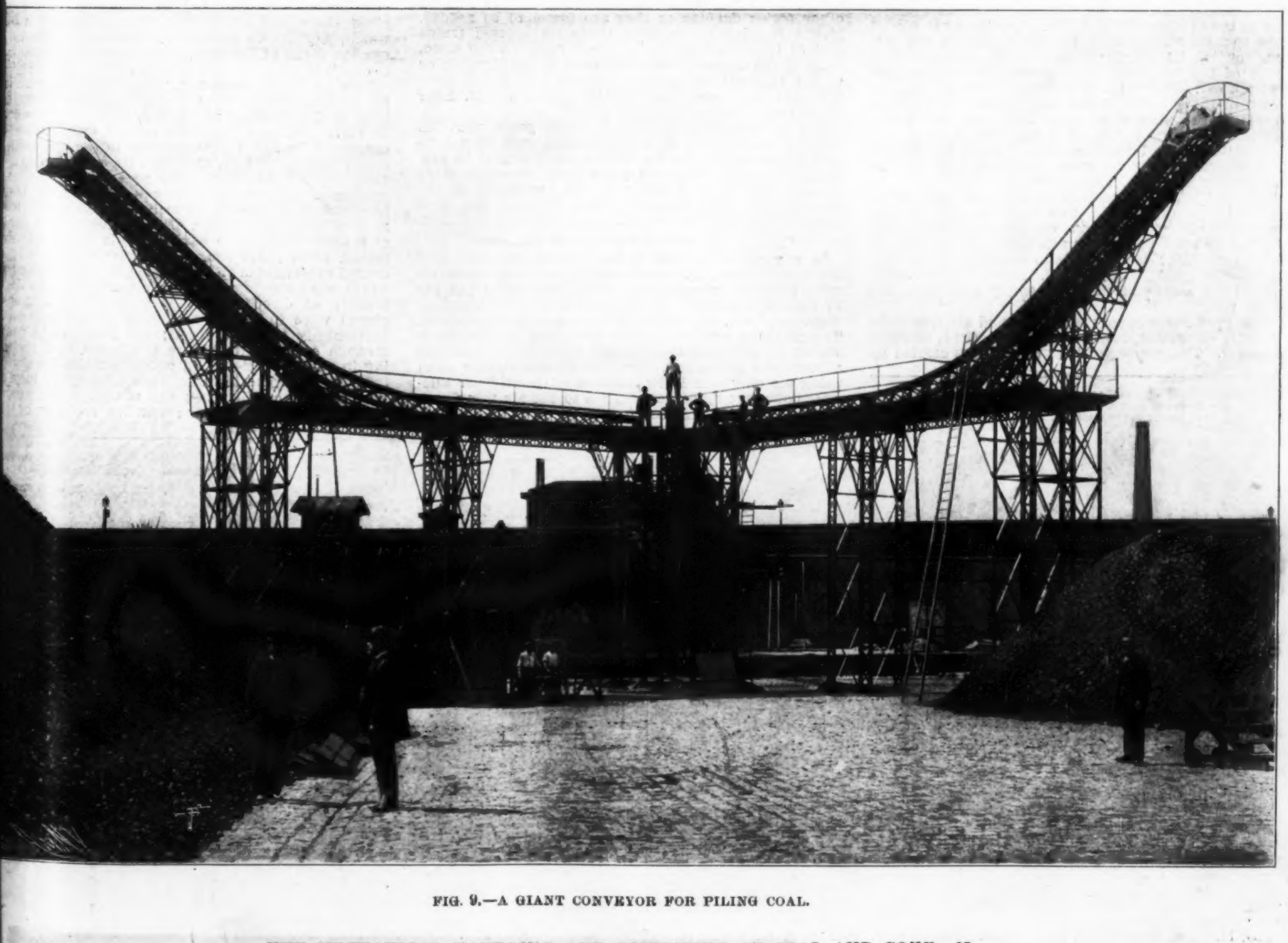


FIG. 9.—A GIANT CONVEYOR FOR PILING COAL.

THE MECHANICAL HANDLING AND CONVEYING OF COAL AND COKE.—II.

[Continued from SUPPLEMENT No. 1445, page 23150.]

THE MECHANICAL CONVEYING OF COAL AND COKE.*—II.

Specially Prepared for the SCIENTIFIC AMERICAN SUPPLEMENT by EMILE GUARINI.

BEFORE passing to the apparatus for placing the materials in heaps, let us mention the carriers with buckets for coke. These are formed of a stationary metallic part constituting the frame itself of the apparatus and of a movable part comprising the buckets, a chain connecting them, and wheels at the extremities around which the chain passes. The buckets are of steel-plate and are designed in such a way as to abut one against the other and thereby prevent the introduction of pieces of coke between two buckets or between two links of the chain. They have a total capacity of 1,220 cubic inches.

The coke is piled up principally by sack conveyors. These apparatus permit of sending the sacks of coke to long distances and of raising them to a height of 65 feet without the necessity of any carriage upon the back of man. Whatever be their type, they consist of a chain starting from supports upon which the bags are placed, and of a stationary frame. The speed of the chain varies from 12 to 16 inches per second.

The horizontal or inclined conveyors (Fig. 8) are usually placed along walls. The upper trackway consists of two steel rails of 2 inches height, of 1 inch outside flange, and of 2 inches width of foot. These are spiked at every 5 feet to horizontal sleepers formed of an angle iron, sealed on the one hand into the wall, and, on the other, carried by two uprights, likewise of angle iron, inserted in the ground. Two angle irons edged with a half-round iron serve as a lower trackway for the return of the conveyor chain. They are riveted to the uprights that support the horizontal sleepers.

The conveyor chain is composed of open and closed links, of closed links provided with lugs, and of plates bolted to the latter. The axles of the wheels are secured to a certain number of these plates, which, as a general rule, are fixed upon the chain in groups of four. Each group receives one bag. These apparatus permit of carrying from 700 to 900 bags an hour from the crushers to the apparatus for placing in heaps.

In the conveyors for piling the coal, the chain is identical with the one just described (Figs. 8 and 9). The conveyor is supported by metallic pillars solidly anchored in the ground, and, as far as possible, exterior to the heaps. They have an inclined way that starts from the platform of the crusher shed and ends at the top of the nearest heap. Some continue horizontally to do duty for other heaps. Advantage is taken of the conveyor to load the cars.

Similar conveyors are used for sending bags under ground to avoid obstructions, and afterward raising them to the height proper for loading wagons.

The piling is done also by telphers, of which the arrangement is seen in Fig. 12 and also Fig. 15 of the next installment of this article. The endless cable is both a carrier and motor. One of the two grooved pulleys over which it passes rotates and is capable of displacing itself in such a way as to cause a variation in the tension of the cables. The bags are placed upon baskets resting upon the cable through the medium of special bearings faced with leather. The plates of the bearing carry two wheels that convert it into a car. The latter is switched automatically, by reason of the velocity of the cable, upon a rolling-way formed by the wing of an angle iron surrounding the pulleys. After the car has left the cable it no longer participates in the latter's motion. Telpherage is really of advantage only for great distances. Its delivering capacity is but 200 bags an hour.

Upon the heaps themselves the bags are carried by monorailways (Fig. 11). The bags brought by the conveyors are placed upon carriers provided with wheels which run upon monorails having an inclination of from .012 to .024 of an inch to the foot. As all the carriers are connected by a cord, those that are loaded descend the slope and raise the empty ones upon the return rail.

Each yard has a supply of curved and straight rails for easily elongating the monorail whenever it becomes necessary. The number of bags that can be carried by this apparatus is very variable, it being possible for the loads to succeed one another without interruption.

(To be concluded.)

* The method of handling coal and coke here described seems distinctly inferior to the American system; still, the method is not without merit and is worth while presenting to readers of the SUPPLEMENT.—ED.

SIBERIAN TRAIN SERVICE.

SINCE September 14, 1902, six trains have been running weekly in either direction between Moscow and the eastern terminus of the Trans-Siberian Railway. In addition to these, since July 14 last, express trains to the number of five per week have been added. It is now stated from St. Petersburg that by a special arrangement between the Russian government and the International Sleeping Car Company the regular service will be augmented or replaced—as may be required—by daily departures of express trains having the new cars *de luxe* of the company. This change will take place July 14, 1904.

FIG. 10.—HORIZONTAL CONVEYOR.

Of the seven express trains that will be running in a year's time, four will be supplied by the Russian railway authorities and three by the sleeping car company. These trains will consist of a baggage car, one saloon and restaurant car, and two first-class and two second-class cars. In case the Russian government desires it, the company alone must run *trains de luxe* on and after July 14, 1905. Such trains will consist only of four first-class cars, and their speed will exceed that of the express trains by twelve hours on the journey between Moscow and Irkutsk. But the company is bound to run only seven pairs of *trains de luxe* every week; as soon as that number is reached the Russian railway authorities will have to furnish other *trains de luxe* as they are found to be needed. If the Russian government sends its express trains east of Irkutsk, then the company must do the same, even if the trains have to be sent to Vladivostok or to the eventual terminus of the Eastern China Railway, but in no case is a greater distance than 4,000 miles to be traversed by one train.

The agreement, which is for twelve years, provides for the construction of the company's cars from Russian material. Only when certain parts cannot be produced in Russia are such parts to be imported from abroad, and in every case with the permission of the government. The Eastern China Railway has been open to general traffic since July 14 last.—N. Y. Times.

In a paper submitted to the Société Internationale des Electriciens, M. de Kowalski describes some results obtained in producing nitric acid from the air by electrical means. The reaction is brought about by "sparking" air, as in the old Cavendish experiment. The potential used was 50,000 volts, and the frequency varied in different experiments from 6,000 to 10,000 alternations per second. The best result obtained when using air only was 1.94 ounces of nitric acid per kilowatt hour, but by adding oxygen to the air this figure was substantially improved.

Correspondence.

THE DISCLOSURE OF A SECRET, AND THE APPLICATION TO AERIAL NAVIGATION.

To the Editor of the SCIENTIFIC AMERICAN SUPPLEMENT:

THE writer had occasion to spend a portion of the year 1897 at the Hacienda de Montepio, which borders on the Gulf of Mexico, at a point about midway between the ports of Alvarado and Coatzacoalcos. During the autumn months the Texas "northers" sometimes sweep down the coast; and with such suddenness that the barometer seldom gives timely warning of their approach. One of these occurred in the morning, and was blowing at the rate of about forty-five miles per hour. When it struck with full force, a large flock of frigate birds were leisurely circling about the cliff of Punta Morillo (390 feet high); and then started for home. With a powerful field-glass the writer watched them move, on a horizontal plane, steadily into the teeth of the gale; and without the stroke of a wing, to travel a distance of seven miles and then settle down on a small island, which they exclusively occupy. Now, all this was neither new nor uncommon; but close at hand was soon to be disclosed the secret of how it was done.

Premising, it may be well to say that, by one of the allwise and marvelous provisions of nature, a feather is so constructed as to offer either the minimum or maximum of resistance, according to the relative direction of the wind which may impinge against it. Living on the place was quite a family of those efficient auxiliaries of the various coast boards of health known as *zopilotes* (turkey buzzards); and being quite unmolested, these birds were very tame, especially while on the wing. These had ranged themselves close to the end of the spacious and picturesque building which serves as headquarters of the property. Some of them were immediately over the balcony, at a height of from 10 to 15 feet; and others were about on a level with the eye of the observer, and quite as near at hand. With the field-glass—through which their movements were observed for nearly an hour—the position of every feather on the underbody of the birds was distinctly visible. The short flexible feathers, which covered the under surfaces of the wings, and also some of the body feathers next to the wings, were strongly *deflected forward*; and were in a state of rapid and violent vibration. Whenever a gust of unusual velocity struck the almost motionless birds, or when any of them desired to go ahead, the rear portion of the inner (tertiary) parts of the wings were perceptibly elevated, and so greatly concaved as to resemble what might be termed the flattened involute of a circle. The tail feathers were also slightly elevated, in order to counteract the depressing effect of the wind upon the increased angles of the upper surfaces of the wings. By this change in wing adjustment, the volume and force of the propulsive wind-eddies were increased, and the birds either maintained their positions or else moved quickly forward, without further effort. During this time the long stiff feathers, attached to the ultimate (primary) wing-joints, did not change in position with respect to the body. On all soaring birds these are evidently merely balancing rudders which, working in unison with the tail, serve to govern the flight of the bird, on a plane perpendicular to themselves.

Two or three years ago, some magazine published an article, written by a gentleman who spent some time in the tree-tops of Florida, in the vain endeavor to solve this problem. He related how, being thus ensconced, he saw a hawk resting in the air, some five or six feet above him, and with its eyes closed, apparently asleep. The surprising part of it was that the gentleman did not, from his point of vantage, instantly discover the secret. Precisely the same principle is involved in the impact of the wind against the sail of a craft going close hauled. This the writer determined, some years ago, by a series of carefully conducted experiments on the Pacific, and when the trade winds were blowing, with their usual remarkable uniformity of direction and velocity. The means employed were to stretch a number of fine brass wires horizontally across the sail; the inner ends passing through eyelets, attached to the hoops, and terminating in suitable weights, in order to maintain a proper tension. Attached to these wires, at regular intervals, were threads of silk floss; and the directions assumed by these threads, and the relative rapidity of their

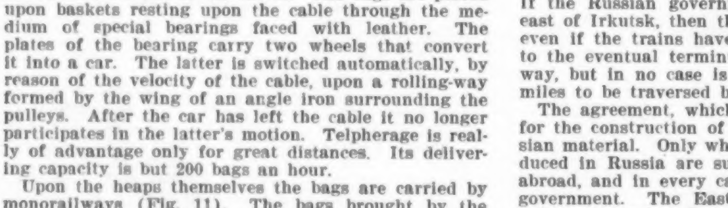


FIG. 11.—THE MONORAIL, SHOWING CARRIER WITH CAPACITY OF TWO SACKS.

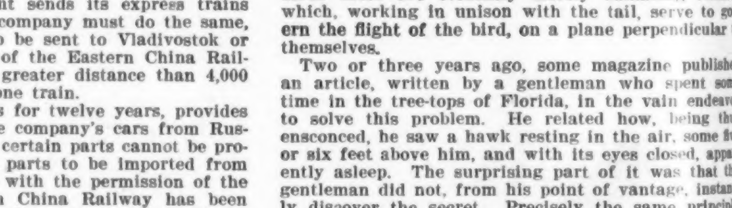


FIG. 12.—CONVEYING THE SACKS ON THE CABLEWAY.

THE MECHANICAL HANDLING AND CONVEYING OF COAL AND COKE.—II.

vibration, showed conclusively that the after part of a sail has much less to do with the propulsion of a vessel than most people imagine. A sail, cut so as to conform to the shape of the wing of the soaring bird, would be more effective than if it were a perfect plane, unless, indeed, some means were devised by which to entirely eliminate the surface friction.

It being thus made apparent how the soaring birds maintain their flight with so little effort, it is quite pertinent to suggest that the adoption of that principle —and also of the approximate form—would be a vast improvement on the present clumsily modeled dirigible balloons. And with respect to aeroplanes, it is of even greater importance. While some well-grounded doubts may exist as to the probable utility of these expensive playthings, any real progress in the art would be welcomed as a matter of scientific interest. Instead of an aero-*plane*, suppose that a modified involute be substituted. Then, if the upper, or convexed, surface were polished, and the under, concaved, surface were provided with elastic spicules, it is certain that the device would have a vastly greater sustaining capacity; and might be made to move into the wind without the application of mechanical power.

By increasing the angle of the aero-involute, it could be made to drift at a somewhat less speed than the velocity of the wind. Obliquity of travel might be attained by means of suitably arranged vertical rudders.

To those who are expending time and money in this direction, these hints are thrown out for whatever they may be worth.

And it needs no prophet to foretell that if a perfect success be attained in the art of aerial navigation, it will be along the lines which Nature has so beautifully exemplified in the flight of the soaring birds.

SIDNEY ORVILLE BROWN.

Mexico, August 15, 1903.

SOME PRINCIPLES THAT MAY BE GUIDES FOR THE APPLIED ARTS.

By G. F. BODLEY, R. A.

ASKED to lecture here to-night, I have set myself, I fear, a somewhat difficult task in speaking to you of some of the principles that rule, or should rule, what are called the "applied arts." It were easy to cite examples of the arts—to describe the great works of the past, to catalogue the achievements that the mind of man has conceived and his hand has wrought. It were easy, I mean, to bring facts before you. It is not so easy to tell of ideals and principles that should guide, and should enlighten the mind of the designer or the doer. Yet all art is a thing to be sought after and to be learnt, and it must needs have its principles. Nevertheless, in some sort art is instinctive, spontaneous, and its happiest achievements are those that spring free, sudden, uninvited, the happy inspiration of the moment. It is not for all thus to conceive or thus to achieve. Rules are best for most of us.

Well, I am to speak to-night of some of the principles that may lead us into, and guide us along, the delightful paths of creative art—creative, for art is nothing if not creative. Are there any such principles? Is art only an inspiration? Or is it only imitative? It cannot be merely an inspiration, for it is certainly learnt, fostered, and nurtured and developed by laborious thought of the mind and by the patient labor of the hand, and by the traditions of the ages. It cannot be only imitative, for where, then, comes in the Creative faculty? An inspiration may plant a seed; but the seedling will not reach perfection, untended and uncultivated.

Here then comes in the use of principles to direct the growth into right ways, to prune, to educe the good, and to root up and reject the bad.

This use, this carrying out, of principles in design, is not, indeed, the most poetical, or the most interesting department of the teaching of art—far from it. It is rather the prose and the common-sense aspect of its initiative. It is very different to that "light that never was on sea or land," it is different to the glad surprise of the joyous thought of an artist's mind, the grand, or the beautiful conception, innate with the added creative power of the hand eager to achieve. Rules and laws are but as schoolmasters, and have a manner of restraining and curbing.

But to go back to what I have said, are there any principles that may guide us along the path of art? I think there are. First and foremost, there is the principle of following Nature—Nature in her stately grandeur or in her calm beauty—Nature from the "human form divine" to the simplest flower or delicate, tiny shell; from the mighty mountain to the tender grass of the valley. In the highest arts, as in sculpture and painting, there is the obvious principle of closely and faithfully following Nature, not indeed without selection and judgment and feeling, and, not, above all, without Imagination. For we must touch all our art work with human feeling and human thought. Nevertheless, the everlasting law for the arts of painting and sculpture is to be in complete harmony with Nature, at her best, and to be faithful and true to her teaching. We know the superlative, the astonishing truthfulness of Greek sculpture; how each fragment found, if it be part of a nude statue, for example, is as delicately modeled as the living flesh and the skin-clothed muscles were—how drapery seems as if it were the very petrifaction of the light, delicate folds of the thin linen that draped the figure. I know not what is most remarkable about Greek sculpture, its beauty or its glad following of Nature. This, then, I would put as the primary rule and principle for all art—the following of Nature; and that not only in the forms and shapes of natural objects, but in giving to all things we make the very spirit of Nature. What lessons of delicate curve and strength and delicate modeling, do we not find in the human figure! Sir Joshua Reynolds wrote: "It seems to me that there is but one presiding principle, which regulates and gives stability to every art. The works, whether of the poets, painters, moralists, or historians, which are built upon general Nature, live for ever."

And this brings me to the next principle that I would mention, one indeed closely allied to that of truth to Nature. It is this—to endow everything we make with the expression of life—to give to all our handmade productions, be they but the common utensils of daily life, be they but pots or pans, or be they crowns for kings and queens, the expression of life. In all the great days of art there was that expression (which, indeed, has a sort of divinity in it) given in all things made. You find it in Greek work; you find it in the work of the middle age, in all the civilized countries, when art was healthy and was growing gradually into the astonishing beauty that was produced in the great days of matured art. Everything after its kind, was made, some more, some less, with an expression of life. In their nervous, graceful, or vigorous curves, in their kindly expression there was life. As you well know, many flowers have an expression, some of the most pleasing nature. They smile at you. Well, in the same way the workers in gold, or in silver, or other metal, or in china, or pottery, gave an expression of life to the things they made, though the thing made had no exact resemblance in form to any natural object.

The thing, be it of the commonest type, be it your ink-pot, your chair or your table, or wine glass, or be it a jeweled cross, or a silver heart for a lady to wear on her breast; be it a scepter for a king, or a drinking cup for a child, one and all had, in the best days of art, an expression, nay, as it were, an endowment of life. The hand and the mind of man, their maker, had so endowed them. No doubt it may require some imagination to see this, and some good things may have it but slightly, and some more, some less.

But now look at modern things of the kind I mean. Except some few made under better auspices, they are dead as the clay or the gold out of which they were made. In the one there is the beautiful curve, full of energy, or it may be of repose, or it is generous of a pleasing and a kindly expression. The other is dull, nay dead, without expression, except indeed it be one of inane ugliness; and even that would seem to have come by chance, so much inanity there is in it. In the one the mind of a man, who loved and enjoyed his work, is reflected. In the other there is none of this. It is vacant, lifeless, hopeless. When you are at a museum of good old art objects, look at them and compare them with nearly all modern manufactures. If you have artistic perceptions you will readily see what I mean. And it is *this* that I mean—the mind, not alone the hand of its maker, has endowed the object with an expression; and following, in all reverence be it spoken, the Divine law of creation, he has breathed into it the spirit of life. Where this is done, we have, so far, a work of art. If it is not done, it is poor stuff at best. And it is not the richness, or the poverty, of the thing that brings this to pass; for the simplest object may have the expression of life, and, indeed, of beauty; and the richest may be wholly without it.

The late Lord Leighton used to have a small Greek lamp on the mantelshelf in his studio. It was utterly simple in its lines, and without what you would call ornament, but it was not only beautifully designed, it was, to my eye, instinct with the expression of life. I have said that nature was our guide; well, chairs and lamps, and the proverbial pot and pans, cannot be made like any natural object, or, if so made, they would be wrong, utterly wrong. But they, and all things can, in different degrees, and in different manners, symbolize life. Is it not this expression of life that makes conventional ornament not only bearable, but pleasant in its place and after its manner? You know how, in every style and manner of architectural art, conventional ornament has played a conspicuous, an important, nay, I may say, a delightful part. Well, why is this conventional ornament not only to be tolerated, but to be a real pleasure? I think, nay I am sure, it is because in all good, intelligently designed conventional ornament there is an expression of life. It is this that gives the soul to art. Beautiful, beyond compare, are the forms of flowers, of leaves, of trees, of the very grass of the field. But more beautiful is their expression of expanding life, whispering, perhaps, and moving to the gentle air. And this expression you can give to the work of hand-made things—manufactures as we call them. I have mentioned the old testimony of the creation, "He breathed into them the breath of life." And man, "whose breath is in his nostrils," so frail and passing, with so brief a life, can, if he will, endow his own handiwork, his own creation, with the very semblance of life. It is this that makes the lesser arts noble. And would not this and other principles raise manufactures that are made by the hand of man, directed by his mind, would they not take us, I would ask, into the region of art? I do not mean into the region of high or fine art. Things may be made, and are made, by machinery, helped by the hand of man, without help from his mind. There is no art in such things, only ingenuity. Others may be made by machinery too, but directed by the mind of man. I mean such things as woven tapestries and carpets, and other textile fabrics, and they come into the region of art. As we say of some things, "it is quite a work of art." We may truly say so of the best kinds of Eastern carpets, so beautifully made, and so beautiful in their coloring.

Have you ever observed how the mind of a weaver of these Oriental carpets works with his hand? For example, when an orange-tinted wool comes against a red, it pales to a more golden hue; when it comes against a blue it will warm or deepen again. The orange against the red would have been hot and unpleasant-looking. Alas! that these Eastern manufactures are so fast degenerating. Indeed, some kinds, or "makes," of carpets that have been beautiful for many centuries (we know some portrayed in the accurate pictures of a Van Eyck or a Memling) have, I am told, recently ceased to be made at all. I hope that Lord Curzon's good work in trying to maintain Indian manufactures may be of use. Not that much Indian furniture is really satisfactory in design. But the carpets and many other textile fabrics are beyond praise. They are delightful; and teach us how color should be treated in manufactures. They are works of art most certainly. It is true that fine art takes us into a higher region and to a nobler ideal. But here at this "Section of the Applied Arts," we are, I suppose, on somewhat lower, perhaps more useful, ground. But even in the weaving of carpets, in their palpitation of color there may be this expression of life as well as in the drawing of their foliage or other ornament.

Another principle is that all our work should be beautiful. Would that we lived with beauty all around us, and had not the deteriorating influence of ugly things that crowd around us in their imbecility! How depressing are all ugly things! How delightful, how elevating is the influence of a thing that is, in its beauty, "a joy for ever"—a thing that becomes almost a friend and a companion. And why? Because it mirrors the mind of a man who has striven to give it an expression, innate with beauty. I should like a crusade preached against the profanity of ugliness, and to see ugly things publicly burnt in one of our great, rich, London squares! I suspect many ugly things would not have to be carried very far to feed the bonfire! Well! taste is growing—let it grow! I have used the phrase "profanity of ugliness." "In the beginning," all things made were pronounced to be "good." I think, therefore, my word "profanity" is not wholly unjustifiable! One could not call the ugly things I mean "good."

Another principle of art that I would mention is that of breadth of effect. It applies largely to artistic manufactures, or manufactures that might be artistic. Now I cannot but think that in all art one thing greatly lacking, in these days, is this grand quality of breadth of effect. I venture to think so of much modern painting, whether of pictures or decorative work. In all the arts breadth of effect is a great quality. Here again look at nature. The low-lying land and the grassy hills, are they not broad in color, in their vast expanse of green? Varied and gradated green, no doubt, as all nature's coloring is gradated, but, broadly, green. And the sky, is not its great dome at times all blue—gradated, indeed, again, to a silvery tint, where it touches the dark green land? And the clouds, are they not at times all tints of gray, and at times all that beautiful color of solemn, subdued purple that we call inky, that is so beautiful against the green of the hill or of the trees? I am not forgetting the sunrise or the sunset; but those are but moments of exceptional beauty that linger but for a little while. And the green of the land may be sprinkled with flowers, but they are but as jewels on a robe of one tint.

The more subordinate the nature of decorative work may be, the more broad it should be in its treatment. For example, mosaic work for a vaulting or a wall is quite the best if it has but few colors. You may have a gold background, and your figures may be—one all in shades of reds, another all in shades of blues or greens; or a purple robe may be lined with green—colors that have a delightful affinity, and the result will be broad and satisfying. So in marble work. Black and white, red and white, green and white—only those two colors together—will be more dignified than if other tints are intermingled, to the loss of breadth of effect. What is it that makes the difference between many new buildings and good old examples of architecture? It is not the charm of age, for that chiefly affects the color. Is it not that the old work has a noble breadth of effect and a unity of idea, restraint, and an avoidance of all discordant elements? While of much modern work must we not say that vulgar confusion, and useless variety and display, take the place of suavity of manner and a dignified and noble breadth of effect? For there is in old buildings a nice economy, not only of material, but of ornament, and there is a satisfying charm about most of them, of almost any period. The old architecture had stately manners. Too many of our new buildings have pretentious ways. I think it is from the lack of the principle of refinement and especially of a delightful breadth of effect that many things suffer nowadays. It is a principle that extends to literature. Unity of idea is a mark of a great poem, or, indeed, of all good literature. But I am trespassing on to other land.

We live at a time in which there is a considerable feeling after a better and more beautiful treatment of designs for new buildings in our streets. They are certainly becoming more ornate, and more pains are being taken to make them more interesting than in days when the long, unlovely streets like Harley Street or Wimpole Street, were built. What seems missing in many, if not most, of these new street fronts is a sense of greater dignity and restraint of character; more refinement and more breadth of effect. In one word, a higher conception and a more refined and broad, and a more reasonable carrying out of such conception. The great principle I have spoken of, refinement, is too often absent. Indeed, too many new buildings cannot but be designated as pretentious and vulgar instead of being dignified and refined. It is a critical time for architecture. I hope we may see better work done, more thorough in the expression of the principles of truth and of a stately beauty, both in the humblest and the noblest buildings.

Another principle is that of delicacy. Look at the infinite delicacy of leaves and grass and flowers, and their infinite refinement of form and texture and of color—the gentle gradations, the melting of one color into another—so subtle, so delicate! Look at the passing cloud shadow on the bare dawn, so gentle, so transparent. Look at the sea, with its purple and green and its soft-toned white, full of gentle shadow, slowly moving in the delicate curve of a cresting wave. In all nature there is delicacy, and in all art, of the finest kind, delicacy has ever been a great principle. Compare old jewelry with new. It is the delicacy of the one, and the coarseness of the other, that makes old jewelry delightful, and most of the modern contemptible. But I must pass on, though I could say much more on this point.

And now one word about color. I can only briefly touch on this. It is a large subject, and color is a thing so subtle, so delicate, so strange in its ways that it seems to be beyond rules and laws. For example, you may place one red against another—a crimson, laky red against an orange red, in other words, you may mingle your different reds together and always with happy result. Who has not seen the peasant children in Italy, in the shaded slums of the old town it may be, or in the country under the bright sunlight. Their dresses are frequently—most frequently—reds of very different tints, scarlet and crimsons, and all harmonize. In pictures by the old masters you will find one figure in robes of one red, and side by side

with it another in a rob_ of a totally different hue of the same color; all is harmonious. Now try to do the same with different greens. You cannot. A warm, fruity green, beautiful in itself, will not harmonize with a cold silvery green, though that too may be beautiful—most beautiful—in itself. I am speaking of decorative painting. Why is this? I can find no reason except that color is so delicate a thing that it is allowed to be free from laws—to be beyond rule, so that I am reminded of a volume of travel in which one of the chapters is headed "The Snakes in Iceland." You turn to the chapter, and all that is said about the subject is "There are no snakes in Iceland"; and so with the laws and principles for color. Indeed I think there are none. Nevertheless, the eye can be trained, and the taste can be cultivated to love the beautiful in color, as in form. For everything is there the law to be beautiful.

Another principal, or should I say a desirable, practice, is that of founding work on what has gone before. It is at times a charge made by somewhat shallow thinkers, if I may say so, that all work must be entirely original and absolutely new. Sir Joshua Reynolds did not think so of works of painting. He said the best work that had been done in the long history of painting was founded on the work that had been already achieved. He says that such work will be the "most original, though it seems like a paradox to say so."

It is, indeed, but reasonable in the different departments of the arts—it is but natural, to found your work on that of the past. You have a thing to do; you have to design for a certain object. Well, you build, as it were, on the foundations of the past. But you see how this or that can be improved on, refined on, or strengthened. You see it with the eyes of your own mind, and conceive it afresh with your own imagination. You develop the original idea; you depart from it; or you give it a new character—a new clothing. In one word, you make it your own. Has not this been so in all the arts? Is it not thus that art hands on its spirit which is immortal? If I were speaking to students of art, I should say, "Fear not to found your work on that of the past ages." Catch the spirit of beautiful work already achieved, and, as it were, grasp the torch from the hand, the doer of work in the past, and throw a newly-directed light with it—a light to fall on a new parting of the ways—ways that may lead to higher heights yet attained, and to pastures new. That is the way to utilize old traditions. You need not ignore them. Do not so; but use them as stepping stones to still higher and nobler imaginings.

I could say much more of the guiding principles for art. I could tell you of the principle of strength, not only of strength of construction, but of strength of artistic expression. I could tell you of delicacy without weakness, and of power without coarseness. Of truth (and, indeed, that should have had the first place) I could tell you of harmony and of the avoidance of all harsh and violent contrasts. I could tell you how the nature of the materials we use often controls the very first idea of a design; and of other characteristics leading to good and artistic work. But I should weary you. Indeed, I fear I have already done so. One word more, and it is this, while such principles as I have feebly touched on are, and should be, as it were, the by-laws of art production, yet, in all the arts, a healthy, well-informed, and well-cultivated imagination is beyond and above all rules.—Journal of the Society of Arts.

NEW MOTOCYCLES.

At the last Automobile and Cycle Exposition at Paris, no less than forty-two types of motor bicycles were shown. Among these, the two principal models were the bicycle with vertical motor on the crank hanger, and that placed obliquely in the frame, or under the properly strengthened lower brace.

As may be conceived, the motor is the essential element of any self-propelling machine, and that is why numerous manufacturers, such as MM. Buchet, Peugeot, Gregoire, Popp, Brousset, Leclercq, and Knap, have this year experimented with special types for motocycles.

It is no longer necessary to eulogize the Buchet

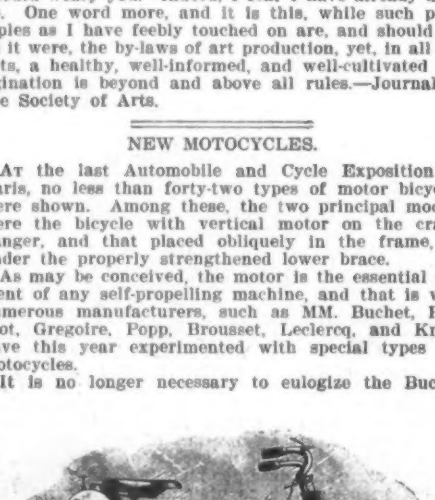


FIG. 1.—BUCHET MOTOR APPLIED TO A MOTOCYCLE.

(Fig. 1) and Leclercq (Fig. 2) motors. The Brousset and Givaudan types (Fig. 3) appear likewise to be constructed with care, while that of Popp (Fig. 4) seems to hold the record for cheapness, since it cost but $30 for a 1¾ horse power.

Two of the motors were exhibited with special mention by reason of their genuine originality, viz.: the "G. V." valveless one, the lightest, with equal power, of all analogous machines, and unquestionably the simplest also; and the "Bichrone" (Fig. 6), a two-cycle motor the running of which seems to be very regular. These two systems, of recent creation, present an unquestionable interest and, by reason of their lightness and extreme simplicity, are remarkably well adapted for the kind of automobile vehicle for which they are designed.

The motors for actuating the two-wheeled automobile vehicles constructed by the Société Française, Peugeot Frères, and Pieper, of Liège, exhibit no particular originality. All these types are single-cylindered and air-cooled by flanges. The two-cylinder motors applied by the Clement establishment to extra rapid racing bicycles have a particularly strong appearance, as shown in Fig. 5. The Georgia Knap motor and motocycle attracted especial attention by reason of the

progressive friction clutch; and the "Stimula" auto bicycle (Fig. 9), an apparatus well conceived in all its details.

There were to be seen at the exhibition this year, for the first time, some motocycles provided with motors cooled by a circulation of water, small types of those used on quadricycles and voiturettes. Let us mention among the types of this kind that appear to

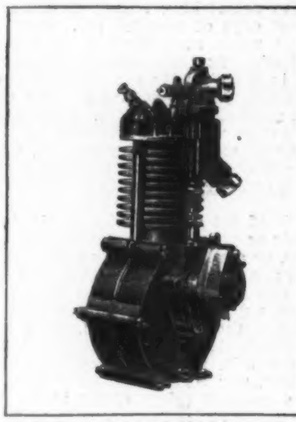


FIG. 2.—LECLERCQ'S "BRUTUS" MOTOR.

FIG. 3.—BROUSSET MOTOR.

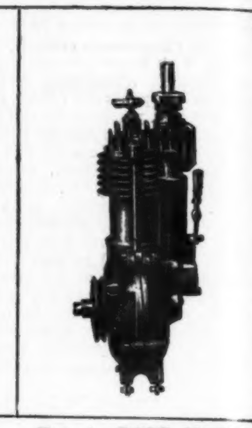


FIG. 4.—POPP MOTOR.

singularity of their association. M. Knap finds that the motors employed for bicycles are much too strong for the work they have to accomplish, and that the transmissions absorb the greater part of the force developed as pure loss. His motor therefore gives but about 268 foot pounds (½ horse power) per second; but such power is nevertheless sufficient to propel the vehicle at a speed of about 25 miles an hour on a

be the best conceived, the Chaufourier "Red Star" and "The Royal" (Fig. 10), and the Piprès de Paillard motors. These motors develop as high as 6 horse power, which permits of obtaining fantastic speeds on a level or of climbing the steepest hills at any speed, without the heating of the cylinder walls producing a diminution of the pressure or a change in the composition of the explosive mixture—a serious cause of weakness in

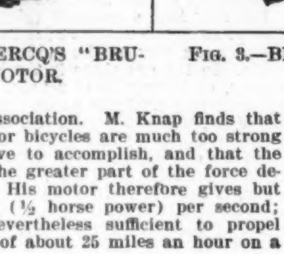


FIG. 5.—TWO-CYLINDER MOTOR.

FIG. 6.—THE "BICHRONE" MOTOR.

level. Such a result is obtained by gearing the motor direct to the rear wheel of the bicycle, by means of a spur gear and pinion. This is perhaps a scientific solution of the problem, but it is evident that, from the viewpoint of elegance, the Knap bicycle leaves something to be desired (Fig. 8).

The motocycle is to become a vehicle for touring and for practical utility, rather than one of sport, in

motors cooled by radiation and convection. But it must be recognized that such an advantage is gained only at the cost of the simplicity of the mechanism, which becomes augmented by a new reservoir for the cooling water, so that the cyclist upon his machine, the frame of which is incumbered by boxes of all shapes and sizes for containing oil, gasoline, water, the coil, the sparking accumulator, etc., has truly the

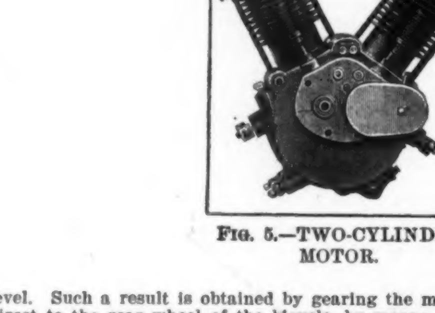


FIG. 7.—THE "AUTO-FAUTEUIL."

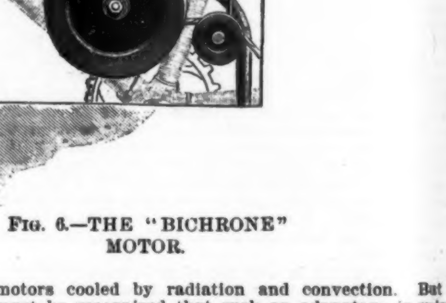


FIG. 8.—THE KNAP MOTOCYCLE.

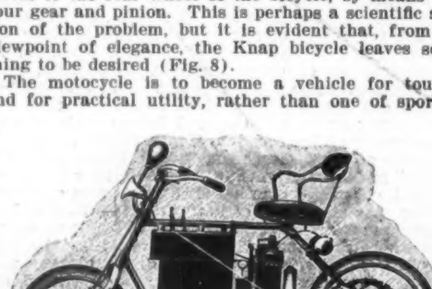


FIG. 9.—THE "STIMULA" MOTOCYCLE.

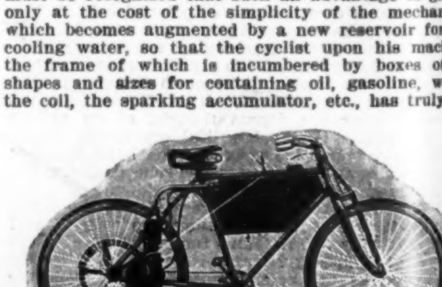


FIG. 10.—THE "ROYAL" MOTOCYCLE.

which comfort and safety are sacrificed for the question of speed. The efforts of manufacturers have therefore been rightly turned in this direction, and the exhibition contained some very practical models of motocycles giving all the comfort desired without exaggeration of speed; such, for example, as the Gauthier "Auto-Fauteuil" (Fig. 7), a machine *de luxe* of great stability, provided with a well-elaborated,

appearance of a traveling agent carrying around samples rather than of a tourist. The æsthetics, as well as the performance, of the motocycle must become improved, in order that the success of this vehicle shall be definitive. After an examination of the novelties for 1903, it may be affirmed that the two-wheeled machine is tending to take the place that has already been predicted for it. The number of models exhibited

in December proves that an impetus has been given, and that the gasoline bicycle has an undoubted future in store for it by reason of the special advantages that it alone possesses. The heavy and ugly automobile tricycle has disappeared and been replaced by the motocycle, which is the democratic auto *par excellence*.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

THE SIEMENS AND HALSKE FIRE ALARMS.*

By the BELGIAN CORRESPONDENT of the SCIENTIFIC AMERICAN.

AT the recent international Congress, at London, for the discussion of preventive measures against fires, two remarkable lectures were delivered, one by Mr. Alex. Siemens, "Upon Safety and Control Arrangements for Fire Alarms," and the other by Mr. G. H. Ostway, "Upon the Necessity of Automatic Fire Alarms having Direct Connection with Engine Houses."

The Siemens & Halske establishment is not a novice in the matter of fire signals, since its first models were invented half a century ago by Dr. Werner Siemens. These have since undergone numerous improvements, and the result has been a series of types, the principal ones of which we have thought it would be of interest to pass in review.

Although the firm has been constructing automatic alarms for a short time past, it seems nevertheless to give preference to non-automatic apparatus. We shall first examine this latter kind, which is divided into two classes—interior alarms and exterior, public ones. The types included in these two classes are mainly distinguished by the control, which is by spring, counterpoise, or magneto. When the starting of the alarm is electric, there are arranged in large establishments, such as theaters, manufactories, etc., secondary alarms that permit of starting the principal alarm from several distant and different places. These secondary alarms consist of push buttons that vary according as the room is dry or damp.

The interior alarms are very appropriate for installations in which the fire signals must be given from a large number of places. They are controlled by a spring, with a pull-button for actuating the contact mechanism, and may be provided with a Morse manipulator and a telephone apparatus (Fig. 1).

The construction of the Siemens & Halske public fire alarms is very simple. In an iron box serving to protect it against the elements and bad treatment is placed a clockwork system (Fig. 2), which the person giving the alarm can start by pulling a handle. The mechanism then sets in motion a contact disk the edge of which is provided with a number of notches corresponding to the number of the alarm. A spring presses upon the teeth of the contact disk. These two pieces, the disk and the spring, are connected on the one hand with the telegraph of the fire engine house, and, on the other, with the battery that furnishes the current.

As the disk revolves, the spring pressing against the periphery makes and breaks the circuit according as it contacts with the disk or falls in notches cut in it. The telegraph apparatus, placed in the engine house, writes the sign transmitted several times upon a tape, while a bell gives the alarm to the firemen. The latter have only to compare the sign inscribed by the telegraph with those of a tablet placed above the apparatus, in order at once to ascertain whence the alarm proceeds.

When, in an installation of fire alarms, there is not a sufficient force of men to watch the apparatus and keep them in repair, and it is consequently necessary to reduce to as great an extent as possible the care required by the latter, a great advantage is to be derived from the use of alarms controlled by a magneto.

In an installation of this kind, the current source consists of a magneto placed in the alarm and actuated by a counterpoise. This sends a series of alternating current impulses into the line, after the counterpoise has been released by pressing a button. Every current impulse produces a movement of the armature of a system of polarized magnets in the central station. This system is connected with an escapement fork, which at each impulse releases a ratchet wheel revolved by a counterpoise, and allows it to move one tooth. The ratchet wheel is connected by gearing with the axis of a pointer, and the advance of this wheel seven teeth causes the advance of the pointer of the alarm from one figure to another upon the dial. The alternating current electric bell in the circuit indicates to the firemen that the pointer is moving, and it is then possible for them to see the number of the line that is operating, which is indicated by the pointer. It is necessary that the pointer shall always be at zero when the line is not in activity. By pulling a ring, it is possible to make it resume this position after each displacement, in order that it may be ready to again indicate when the next signal is sent in. The bell is thrown out of circuit at the same time. The alarms are, in addition, provided with a socket to receive the plug of a portable telephone, so as to permit the different alarm stations to communicate with each other and the central office (Fig. 3).

In order to permit the public the more easily to find the alarm boxes during the night, one of the latest post models (Fig. 4), is surmounted by a bracket supporting a lamp. This latter, which is provided with red glass with an inscription in white, can be distinguished at a glance from other lamps. A reflector illuminates the handle of the alarm and the directions for manipulating it, with a brilliancy almost equal to that of daylight. Such a method of lighting also attracts attention to the location of the alarm, which may (and this is a new improvement) be constructed as a combined fire and accident alarm (Fig. 5).

But all these apparatus have one defect in common, and that is that of necessitating the intervention of man. Now, it is asserted that in case of fire it is rare that a person thinks of making use of an alarm. It is in order to remedy such inconvenience that the Siemens establishment is constructing, in addition to the models that we have mentioned, some types of automatic alarms. Figs. 6 and 7 represent an automatic alarm provided with a perforated protecting box. The most important part of this alarm is a thermometer tube (Fig. 8), the bulb of which holds a spring switch out of contact. When the temperature rises, the bulb bursts, and the spring is released and closes the circuit. The system can naturally be combined in an inverse manner, that is to say, in such a way that the breakage of the bulb shall involve that of the current. It is possible also to join thereto an alarm signal acting in an apartment at the same time that the main alarm is operating at the engine house.

FIG. 2.—PUBLIC FIRE ALARM, ACTUATED BY COUNTERWEIGHT.

The use of a constant current is evidently recommendable, since it permits of a perpetual control of the state of the installation. However, firemen are not much disposed to admit such a system on account of the false alarms that may result from the least accidental mechanical cause.

In order to remedy such an inconvenience, the Siemens & Halske firm has devised a clock that runs fourteen days and is provided with an arrangement, which, automatically and with a determinate motion, puts in circuit an electrically started alarm. The clock is the same as any other, except that it is provided with a second dial divided into 24 hours, and has two indicators that may be placed independently of each other at any moment of the day or night. These indicators always remain in the position in which they have been placed. Each of them is provided with a small arrow that turns toward its mate and shows that during the time indicated by the space separating the indicators, the electric alarm is directly put in circuit with the engine house. During the remainder of the time, the firemen can be notified only when the fire has been discovered. A supplemental handle permits of putting the alarm in circuit independently of the automatic arrangement.

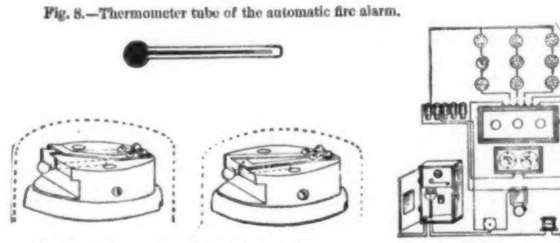
A complete installation of a Siemens & Halske automatic fire alarm comprises (Fig. 9), in addition to the automatic alarm, a tablet for the local determination of the fire, an alarm bell for cases in which the alarm is not in circuit, a galvanoscope and a clock with a device for putting in circuit the electrically started alarm which it is provided with. Owing to this apparatus, the firemen can, without any trouble, exercise an efficacious control and determine in each case the times during which the automatic alarm should be in circuit.

Such, briefly, is a résumé of the activity of the Siemens & Halske establishment in the domain of fire alarms. We have evidently not exhausted the list of all the types constructed by this house, but what we have said will suffice, we think, to show the perseverance with which this house has endeavored to introduce into its apparatus all the improvements possible down to the smallest details, into which it has been impossible for us to enter.

It is to be regretted, however, that all this activity and ingenuity cannot prevail against one defect inherent in all alarms with wires, and which experiment has often demonstrated, and that is the destruction of the wires by fire, which so often occurs before it has been possible to use the apparatus. In this respect, wireless transmission presents an indisputable superiority, and the more so in that the distances being short, it is devoid of all the inconveniences and defects of long distance wireless telegraphy.

The day is perhaps not far distant in which such application will be the most practical of all those in which wireless telegraphy has up to the present been employed.

Fig. 8.—Thermometer tube of the automatic fire alarm.



Figs. 6 and 7.—Automatic fire alarm switch. Fig. 9.

DIAGRAMS OF CIRCUITS AND APPARATUS OF THE AUTOMATIC FIRE ALARM.

FIG. 4.—ALARM WITH ILLUMINATED SIGN.

FIG. 1.—SPRING-OPERATED INTERIOR ALARM.

FIG. 3.—ALARM ARRANGED AS A TELEPHONE STATION.

FIG. 5.—BERLIN FIRE AND ACCIDENT ALARM, SPRING-CONTROLLED.

* Specially prepared and translated for the SCIENTIFIC AMERICAN SUPPLEMENT.

CONTEMPORARY ELECTRICAL SCIENCE.*

ELECTROLYTIC SUPEROXIDES.—It has hitherto always been supposed that the lead peroxide deposited at the anode of a solution of a lead salt traversed by a current is the binoxide of lead, PbO_2, and the weight-ratio of lead to oxide has been given as 0.866, that being the ratio of the molecular weights of Pb and PbO_2. A. Hollard has, however, found that 0.866 is too great, and that higher oxides are deposited. Also, that the proportion of these higher oxides is the greater the smaller the concentration of the lead in solution. He used platinum electrodes, the anode being platinized, and added nitrate of copper to the bath so as to get a compact deposit of lead. The ratio $Pb : PbO_2$ was found to vary from 0.740 to 0.861 as the concentration was increased. There was always more oxygen deposited at the anode than was necessary for forming PbO_2. In fact, it is most probable that very high oxides were formed, but the author has not determined their exact nature. Lead is not the only metal showing this phenomenon. An alkaline solution of nickel pyrophosphate yields an oxide corresponding to the formula NiO_5, and a solution of sulphate of bismuth containing a little nitric acid and copper sulphate yields an oxide of the formula Bi_2O_7. These have only been obtained in dilute solutions, as the salts are rather insoluble.—A. Hollard, Comptes Rendus, January 26, 1903.

LARGE INDUCTION COILS.—Maxwell's formula for the inductance of a coil of rectangular cross-section may be put into the form

$$L = 4\pi a n^2\left[\log_e\frac{8a}{r} - f(\theta)\right],$$

where a is the mean radius of the coil, n the number of turns, r the diagonal of the cross-section, and $f(\theta)$ a term depending only upon the shape of the cross-section. For a square cross-section, $f(\theta) = 0.83$. J. E. Ives has calculated the inductances of seven coils of varying dimensions constructed with wires whose centers were 1-20 inch apart. He finds that a coil of maximum inductance must have a square cross-section; and that the inductance of a coil, with a given length of wire, increases rapidly as the mean radius is increased up to the maximum inductance, and then, as the mean radius is increased still further, decreases very slowly. Therefore, it is better to make the mean radius too great than too small. For coils of maximum inductance, the inductance increases very rapidly as the length of wire used increases, but not quite as fast as the square of the length. Thus the maximum inductance obtained with 5,000 feet of wire was 1.05 henries, and with 10,000 feet of wire it was 3.33 henries.—J. Ives, Phys. Rev., February, 1903.

INTENSITY AND WAVE-LENGTH OF RÖNTGEN RAYS.—G. Holtsmark utilizes the secondary rays produced by the impact of Röntgen rays in order to measure the intensity of the latter. This is necessary on account of the uncertainty which attaches to their measurement by means of the photometric and ionization methods. A plate of lead or platinum is incased in an aluminium box and exposed to X-rays. The secondary rays produce a negative charge on the aluminium and a positive charge on the lead or platinum. On connecting the latter with the earth, a continuous current may be observed and measured. This current is directly proportional to the intensity of the Röntgen rays. The author has used this method for the measurement of the absorption of X-rays by various metals. Taking the values obtained, and using Helmholtz's theory of dispersion, he shows that the wave-length of a radiation is proportional to the square root of the coefficient of absorption. In Röntgen rays, the refractive index equals unity, as it should if the frequency is about the same as the frequency of vibration of the electrons, or greater than that. The values for the wave-length vary according to the metal used for absorption. The highest value is 51.8 $\mu\mu$, obtained from gold, and the lowest 2.4 $\mu\mu$, obtained from steel and zinc.—G. Holtsmark, Ann. der Physik, No. 3, 1903.

EFFICIENCY OF THE MERCURY ARC.—W. C. Geer has found that the efficiency of the mercury arc is far and away superior to that of any other artificial illuminant. Taking the efficiency of an Argand gas burner as 0.016 and that of an incandescent lamp as 0.06, the efficiency of the arc light is 0.1, that of acetylene gas the same, and that of the Geissler tube 0.32. Now the author finds that the efficiency of the mercury arc varies from 0.41 to 0.48, or, in other words, that the proportion of energy supplied which is converted into visible light is nearly 50 per cent. This is the highest known radiant efficiency. In measuring the efficiency, the author used a thermopile, and separated the heat rays from the light rays by interposing a water cell and an iodine cell. He also took care to allow for the heat radiated from the walls of the tube. This is very high, probably owing to the absorption of rays of great wave-length, and is sufficient to make the mercury boil in a very short time. The author worked with very short exposures, and recorded the cooling curve with the aid of a chronograph. The distance between the mercury terminals was about 2 centimeters, the arc was 5 centimeters long, and the energy was supplied by a 110-volt direct-current circuit.—W. C. Geer, Phys. Rev., February, 1903.

DARK CATHODE SPACE.—A. Wehnelt has made some careful measurements of the distribution of potential in the dark cathode space. He finds that Graham's maxima and minima do not exist, but must be attributed to faults introduced by the use of double probes. Schuster's interpolation formula

$$V_x = V_0(1 - e^{-Kx})$$

is not confirmed. When the cathode is closely surrounded by glass walls there are great transverse differences of potential between the wall and the axis of the tube. The equi-potential surfaces are not planes, but are characteristically curved. The path of the cathode rays is governed by these equipotential surfaces. When a spherical cathode is in an open space, the total free electricity round it is positive. The walls of the tube act practically as anodes, and it is, therefore, the canal rays, and not the cathode rays, which get crowded toward the axis of the tube. This implies that the positive particles are the ones which really govern the distribution of potential, and the negative electrons elicited by them follow the field created by the positive ions. Cathode rays which do not proceed from the center of the cathode are strongly deflected, and produce little fluorescence.—A. Wehnelt, Ann. der Physik., No. 3, 1903.

PRESSURE IN THE MERCURY ARC.—J. Stark and M. Reich determine the pressure in the mercury arc by attaching a manometer tube direct to the mercury vessels. They find that if the mercury arc plays in a tube without a condensing vessel, the vapor pressure rises rapidly in the first two minutes. When the glass tube has grown so hot that small mercury droplets evaporate inside, the pressure rises rapidly from 2 millimeters to 10 millimeters. At the same time the current decreases and the difference of potential of the electrodes increases. If, on the other hand, the tube is provided with a condensing attachment, then, on closing the circuit, the vapor pressure increases during the first few minutes to some 5 millimeters, and remains steady after that. The condensing vapor, as it enters the condensing vessel, glows with a reddish color, and shows the same spectrum line as the arc, except that the less refrangible lines are accentuated. The condensing vapor is, therefore, cooler, but still hot enough to glow. As the difference of pressure between the arc and the condensing vessel increases, the condensing vapor contracts more and more into a sheaf, and finally becomes a cylindrical pencil. While it is still a divergent sheaf it shows a kind of stratification.—Stark and Reich, Physikal. Zeitschr., March 1, 1903.

DIELECTRIC CONSTANTS OF LIQUIDS.—Observations made hitherto have shown that the Clausius-Mossotti formula $\frac{D-1}{D+2}v$ depends upon the temperature. K. Tangl has extended the observations over a wide range of temperatures in order to find whether the formula could be used as an index of chemical change, more especially in view of the parallelism between dielectric constant and degree of dissociation indicated by Nernst. The results show that Nernst's method is available for temperatures ranging from 20 deg. to 180 deg. in the case of benzol, toluol, xylol, carbon bisulphide, and chloroform, and that ether can be followed right up to its critical temperature (192 deg.). The first-named liquids show a practically linear decrease of dielectric constant. Ether and chloroform show nearly the same course, but as the former approaches its critical temperature there is a rapid falling off. Ether also shows an anomaly in its dielectric constant at the critical temperature, being still much greater than the square of its refractive index for infinitely long waves. Of the substances enumerated, xylol is the only one which gives a constant value for the formula. In the other substances there is a decrease of from 5 to 17 per cent between 0 deg. and 200 deg.—K. Tangl, Ann. der Physik., No. 4, 1903.

ELECTRIC PROPERTIES OF GASEOUS MIXTURES.—The electric discharge called by Bouty the "effluvium" is incapable of changing the physical or chemical constitution of the gas through which it passes. It does not produce the explosion of an explosive mixture, nor does it produce an appreciable change in the pressure of the gas. The same author has investigated the dielectric strength of mixtures of hydrogen with various other gases. At high pressures the critical field is sensibly a linear function of the pressure, independently of the thickness of the gaseous layer, whereas at low pressures the walls exert a complex disturbing action, either on their own account or through a gaseous layer condensed upon them. The author, therefore, confined his experiments to pressures above several millimeters of mercury. In one class of mixtures the critical field is the exact mean of the critical fields of the gases taken separately at the pressure of the mixture. Such mixtures are those of CO and CO_2, or CO and H, which do not act chemically upon each other. It is more remarkable that the same law holds good for a mixture of nitrogen protoxide and hydrogen. Another remarkable case, but in the other sense, is the decided reduction of the critical field in a mixture of hydrogen and carbon dioxide.—Bouty, Comptes Rendus, March 16, 1903.

THE METALS AND MAXWELL'S THEORY.—Maxwell's theory has hitherto been in contradiction with the fact that the series of metals arranged according to transparency is not the same as the series arranged according to resistance. Hagen and Rubens have, however, now found that the theory is strictly verified in a region of wave-lengths where the proper vibration of the metallic molecules does not influence the result. At the greater wave-lengths, platinum becomes distinctly more transparent than gold and silver, and bismuth, which intercepts 99.9 per cent of ordinary light, intercepts only 90 per cent of waves 4,000 $\mu\mu$ long. The transparency of these metals for long waves cannot easily be observed, since no carrier exists sufficiently transparent to bear the thin metallic sheets without disturbing the result. The authors, therefore, studied the reflective power of the metals in the shape of cast concave mirrors, 30 centimeters in radius and 4 centimeters in aperture. They found that as soon as the wave-length becomes as great as 12,000 $\mu\mu$, the molecular vibrations of the metals are without any influence, and the transparency series is the same as the resistivity series. The magnetism of iron and steel cannot follow a frequency of 2.5×10^{13} vibrations per second, and so these metals also fit into the series.—Hagen and Rubens, Sitzungsber. Akad. Berlin, 13, 1903.

EARTHQUAKES AND MAGNETOGRAPHS.—C. C. Farr reports that when in November, 1901, New Zealand was visited by a severe succession of earthquakes, the magnetographs of the Christchurch Observatory recorded the shocks in a peculiar manner. The first shock threw the vertical force instrument out of adjustment, leaving the others unharmed. The observers thereupon ran the magnetographs at a high speed in order to record the shocks. Four shocks were thus recorded, all of them perceptible to some of the residents of the Cheviot District 60 miles away, but none of them felt in Christchurch. There were also on the sheets many small, sudden irregularities which could scarcely be attributed to ordinary magnetic phenomena. The declination records show a damped wave with a period of 137 seconds. Some of these disturbances appear to be magnetic concomitants of the earthquake, since some of the seismograph disturbances were not recorded by the magnetographs at all. An interesting subsequent case is mentioned. On January 9, 1902, the magnetographs recorded a disturbance of a seismic character which lasted 38 minutes. Comparison with a seismograph showed that the magnetic disturbance had preceded the earthquake by 27 minutes, and ended 37 minutes before it. This indicates a possibility of predicting earthquakes magnetically.—C. C. Farr, Terr. Magnetism, December, 1902.

* Compiled by E. E. Fournier d'Albe in the Electrician.

PRACTICAL RECIPES FOR SILVERING.

SILVERING ON BRASS.—The following are experimental data:

1. Rub the brass dry with silver chloride. A thin silvering is thus produced.

2. If the chloride is moistened with water and heated to ebullition, the brass is corroded and not silvered.

3. The silvering is slight when the brass is heated in water containing the silver chloride in suspension.

4. Under these conditions the copper does not decompose the silver chloride.

5. The silvering is accomplished well and rapidly if the brass is rubbed with a mixture of silver chloride, 6 parts; sodium chloride, 6 parts; cream of tartar, 6 parts. Better success still is attained by heating the brass in a concentrated solution of sea-salt or sal-ammoniac with the silver chloride. The silver chloride is obtained by pouring a solution of sea-salt in another of silver nitrate until no precipitate is formed. The mixture is allowed to repose a short time, then decanted, and the white precipitate collected. It should be employed immediately, because it is decomposed by the light.

6. Sal-ammoniac acts more efficaciously than sea-salt.

7. The silvering obtained by these processes has a greenish yellow tint, which disappears when the objects are rubbed with cream of tartar.

8. If the brass is rubbed with a mixture of silver chloride, sea-salt and mercury, it takes on the appearance of mercury. If heated to volatilize the mercury, it assumes a blackish tint, which disappears on rubbing it with cream of tartar. The brass then has a good, white appearance and is silvered solidly.

9. The following method is employed in France for competing with galvanic processes. After cleaning the object chemically and thoroughly, it is placed on a layer of saw-dust and heated to about 100 deg. C. A leaf of silver is then applied, which adheres so well that nothing remains except to burnish in order to secure a good silvering.

Silvering on Copper.—The metal, well cleaned, is placed in a solution of silver nitrate. When the precipitation of the silver is complete, it is wiped with paper. The copper is then rubbed with the following mixture:

Water, 1 part; potassium tartrate, 3 parts; sodium chloride, 3 parts; alum, 2 parts. The white of the silver immediately appears. It becomes more brilliant on rubbing with a chamois skin.

Silvering by Immersion.—Small objects may be silvered by simple immersion, when only a thin layer of silver is necessary.

The following are compositions suitable for this method:

1. Silver chloride and cream of tartar in equal parts.

2. Cream of tartar, 8 parts; silver chloride, 1 part; alum, 2 parts; common salt, 8 parts.

3. Plaster, 1 part; silver chloride, 1 part; common salt, 1.25 parts; potash, 3 parts.

4. Silver chloride or other salt of silver, 15 parts, in 100 parts of sodium hyposulphite.

When one of these compositions is prepared, a little water is added, until the mass takes on the consistency of cream. The objects are immersed and moved around in it, and then rubbed until the desired brilliancy is obtained.

A mixture of 1 part of silver chloride with 80 or 100 parts of cream of tartar and sea-salt may also be employed. This solution is made in boiling water, and the object plunged into the hot liquid. The best results are obtained when the solution has been prepared some days beforehand.

Finally, another solution, though very poisonous, may be formed with 60 parts of potassium cyanide and 10 parts of silver nitrate in 1,000 parts of water.

Galvanic Bath.—The most commonly employed bath is composed of distilled water, 1,000 grammes; potassium cyanide, 50 grammes; silver cyanide, 25 grammes. These products should be quite pure.

If a simple apparatus is desired, there may be put into a porous vessel a solution of 10 per cent of potassium cyanide or sea-salt with the zinc cylinder. Some copper plates attached to the zinc will sustain the pieces in the silver bath.

The following bath does not contain cyanide: A solution of iodide of silver and of potassium is prepared, 6.66 grammes of silver nitrate dissolved in it, and 500 grammes of iodide of potassium added. The anode is a plate of gold, pure or alloyed with silver. The current ought to be weak, in order not to decompose the potassium iodide. Generally thirty minutes are taken for the operation. The objects from the bath ought to be plunged at once into another, formed of 1 part of potassium iodide and 4 parts of water. This process is less economical than that of the silver cyanide.

Test of the Bath.—In order to judge whether the bath contains the correct proportions of silver and cyanide, 25 parts are poured into a rather high glass, and a solution of 1 per cent of crystallized silver nitrate added, drop by drop, while shaking constantly. If the precipitate formed is dissolved quickly with little agitation of the liquid, there is too little silver. If it does not dissolve when shaken smartly, there is

not sufficient cyanide. If it dissolves well, but more and more slowly, the bath consists of the right proportions.

Color of the Metallic Deposit.—Sometimes the covering of silver is not white, but verges on yellow or rose. This results from impurities. The yellowish tint is due to the presence of sub-cyanide of silver in the layer; the rose tint to the presence of copper. The color of the silver deposit and the constitution of the bath may be improved by pouring ammonia into the latter, in order to remove all excess of cyanide in the free state.

When the deposit is white, but does not present the brilliancy of metallic silver, this may be obtained either by means of the burnisher or by the simple addition of 55 grammes of carbon bisulphide per liter of the bath. The brilliancy begins to appear on the lower part of the piece and extends quickly over all the surface.

The brilliant deposit of silver blackens rapidly when the objects are withdrawn from the bath, unless they are immersed for some time in boiling water. Then they should be dried in the saw-dust of boxwood or mahogany.

On Glass.—Böttger recommends the following process: Melt 4 grammes of pulverized silver nitrate in concentrated ammonia, add 1 gramme of ammonium sulphate and 350 cubic centimeters of water. Dissolve separately 1.2 grammes of fecula or grape sugar and 3 grammes of caustic potash in 350 cubic centimeters of distilled water. At the time of operating, take equal parts of the two liquids and apply the mixture over the surface to be silvered.

On Glass Flasks.—The flask is heated cautiously, and a hot amalgam, consisting of 250 parts of mercury, 1 of bismuth, 1 of lead, and 1 of tin, is poured in. The flask is turned so that the amalgam comes into contact with all the points of the interior surface.

On Crystal.—Mirrors.—1. The plate is cleaned perfectly and laid horizontally on a table. For a surface of one square meter, the two following solutions are prepared:

a. Distilled water, 1 liter; double tartrate of soda and potash, 10 grammes. The tartrate is put in an enameled receiver with ¼ of a liter of water. About 0.5 gramme of silver nitrate is added. It is boiled to complete the solution, the remainder of the water is added and the whole filtered.

b. Melted nitrate of silver, 5 grammes; pure ammonia, 3 grammes; distilled water, 1 liter. The silver nitrate is dissolved in the ammonia and shaken until complete dissolution; water is added, and the whole filtered.

The two solutions are mixed at the time of use, and about 20 cubic centimeters poured on the plate, spreading the liquid with a very clear chamois skin. The rest of the preparation is then immediately poured on and spreads of itself. The silver will be precipitated on the glass in the metallic state in 30 or 40 seconds and will be quite adherent. The liquid is removed by raising the glass on one side. A sponge is lightly passed over, and the glass rinsed. It is dried by placing it in a vertical position. After drying, it is covered with a layer of varnish or preserving paint by means of the brush.

To obtain good results, it is necessary to keep the surrounding temperature between 25 and 30 deg. C. and always employ distilled water, even for washing the receivers.

2. The following solutions are prepared:

a. Melted silver nitrate, 10 grammes; distilled water, 200 grammes; ammonia is added in just sufficient quantity to redissolve the precipitate formed at the beginning; afterward 500 cubic centimeters of a solution of pure soda of the density of 1.035 is poured into the liquid. An abundant black precipitate is produced, which is made to disappear with a few drops of ammonia. Finally, the water is diluted to a volume of 1,500 cubic centimeters. Then a dilute solution of silver nitrate is added, drop by drop, until the last drop poured in produces a persistent precipitate.

b. Lactose 1 part, hot water 10 parts. After cleaning the glass well with distilled water, and afterward with alcohol, 10 volumes of *a* are poured into 10 volumes of *b*; then the piece to be silvered is dipped in. The silver is deposited slowly in a very thin layer, 1-300 of a millimeter for 2.2 grammes of silver per square meter. Afterward the piece is carefully washed in distilled water and dried, avoiding touching the silver, even with a fine cloth. In this way a very distinct mirror is secured. This process is employed for the silvering of the concave glasses of telescopes.

3. MM. Auguste and Louis Lumière have discovered that formic aldehyde furnishes with ammoniacal solutions of silver nitrate adherent layers, which are readily cleaned. It is to be noted that by this process almost all the silver contained in the baths is deposited on the glass. Thus, loss or costly recovery of the residues is avoided. This new process has also the advantage of being very simple. After numerous experiments, MM. Lumière have advised the following formula as giving the best results:

Take 100 cubic centimeters of a ten per cent solution of silver nitrate, and add, drop by drop, an amount of ammonia exactly sufficient to redissolve the precipitate at first formed. Care should be observed to avoid an excess of ammonia, which would interfere with the formation of the deposit. The volume is afterward made up to a liter by the addition of distilled water, and thus a solution obtained called *A*. Then a solution of 40 per cent formic aldehyde of commerce is diluted with distilled water so as to bring it to one per cent. This solution is denominated *B*. The glass to be silvered is carefully cleaned with a chamois skin, dipped into English "red-stuff," and at the time of operating, two volumes of solution *A* and one of solution *B* are mixed rapidly and thoroughly, and poured on the glass without stopping. At the end of five or ten minutes, at the temperature of 15 to 19 deg. C., all the silver of the solution has been deposited on the glass in a brilliant layer, which is washed under a cock. It is allowed to dry, and there is nothing further to be done except to varnish, provided the layer, which is in immediate contact with the glass, is utilized as a reflecting surface. Otherwise, as happens with some astronomical instruments, it is necessary to polish with the ordinary precautions.

Desilvering.—To dissolve the silver covering of a metallic object, a bath is made use of, composed of 66 per cent sulphuric acid, 3 parts, and 40 per cent nitric acid, 1 part. This mixture is heated to about 80 deg. C., and the objects to be desilvered are suspended in it by means of a copper wire. The operation is accomplished in a few seconds. The objects are washed and then dried in sawdust.—Translated from the Formulaire Industriel.

THE MANUFACTURE OF ROSIN OIL.

ROSIN oils are more or less thickly flowing liquids produced by the dry distillation of colophony. They are largely used for pigment painting and in the manufacture of varnishes and printers' ink, and also as a substitute for oil of turpentine in thinning linseed oil varnishes. They are also used in floor-cloth manufacture and as lubricants. Most makers of printers' ink who use rosin oils prepare them themselves, but, in general, the preparation is a special branch, of which the following details will be of interest.

As regards the amount of rosin oil obtainable from any given weight of colophony, the figures given in books vary somewhat widely. For example, Dr. Winckler gives the following yield from 1,000 pounds of American rosin:

Crude pinoline and water, giving about 2 pounds of pure pinoline for burning in camphine lamps	90 to 100 pounds
Crude rosin oil...........	712 to 760 pounds
Pitch (left as a residue in the still)............	70 to 80 pounds

Herzog's figures for the same are:

Crude pinoline and water.	90 to 100 pounds
Crude rosin oil...........	720 pounds
Pitch	80 pounds

Dr. Bersch's figures for the same are:

Pyroligneous acid	55 pounds
Crude pinoline	100 to 110 pounds
Crude blue rosin oil (up to .93 S.G.)	600 to 700 pounds
Crude rosin oil (up to .94 S.G.)	100 pounds
Black pitch	100 to 150 pounds

Dr. Thenius' figures for the same are:

Pyroligneous acid	57 pounds
Crude rosin oil of .89 S.G.	114 pounds
Crude blue rosin oil of .93 S.G.	500 pounds
Crude rosin oil (train oil) of .94 S.G...............	104 pounds
Pitch	185 pounds

Boly's figures for the same, distilled, however, with from 2½ per cent to 5 per cent of paraffin oil, to prevent frothing, are as follows:

Crude pinoline and water.	60 to 80 pounds
Yellow crude rosin oil....	500 to 550 pounds
Blue crude rosin oil......	150 to 200 pounds
Green crude rosin oil.....	60 to 70 pounds
Residue (valueless)	150 pounds

The figures depend upon many causes, such as the apparatus and the amount of heat used, the manner in which the distillation is carried out, etc.

The distillation of colophony by superheated steam is not often practised, and its interest is as yet chiefly theoretical. Neither has distillation under pressure yet been adopted, and the only method calling for our attention of preparing rosin oil is fractional distillation over a naked fire, either of coal, or of fuel provided by the gases escaping from the distilling rosin itself. The lower part of the still is prevented from coming into contact with the flames by a perforated baffle plate. The still is of iron, either wrought or cast, the former being preferable. They are used in all manner of sizes, from a capacity of 2 hundredweight to one of 5 tons. The bigger they are the better, provided they can be filled. A large still is far more easily managed than a small one, and the course of the distillation is much more regular and certain. The best rule is to have your still capable of holding 5 hundredweight for every 4 hundredweight of charge. This obviates the risk of boiling over, as it allows room for frothing.

The condensing arrangements are of great importance. For the best work a simple worm-condenser is only sufficient if of great length. Two condensers should be provided, one for the rosin oils and the other for the earlier distillates. It is easy to arrange valves so as to turn the current of vapor from one condenser to the other at the right moment. A large tap must be provided in the bottom of the still for running out the pitch at the end of the distillation. In some works it is baled out through a manhole, with great waste of time and labor.

As above stated, steam distillation is not much resorted to. It is, however, the method of the future, as it is infinitely superior to direct fire heating in every way. It avoids overheating, as the temperature can be regulated to a nicety and with a quickness impossible in the case of a naked fire. It is sufficiently obvious that for a fractional distillation process, such as the manufacture of rosin oil is, too much importance cannot be laid to the efficient regulation of temperature. Again, when superheated steam is blown into the still, the distillation is much more rapid, especially with the heavier oils, than is the case when an open fire is employed. There being no flame, too, all danger of burning vapors issuing from the still is avoided. Many accidents of this nature are caused by defective joints, when the stills are over a naked flame. The use of steam has this further advantage, that the stills last very much longer. They are not heated from the outside or exposed to the action of hot combustion gases. In fact, with steam distillation, an iron rosin still would last practically forever. It is a proved fact that the distillates got with steam are more abundant, and of paler color and better quality than they can be got by any other means.

When steam is used, the combustible gases from the still need not be wasted, as they can be taken by piping into the boiler house, where, being burnt in the grate, they save coal. In some distilleries the receivers are provided with long ventilating tubes, which carry these gases above the roof and allow them to escape into the atmosphere. The air is thereby polluted, and the distiller suffers loss. The history of manufacturing industries shows clearly that these distillers will continue to inflict this loss upon themselves and this nuisance upon their neighbors until legislation steps in to protect both parties.—Farben Zeitung.

THE BLEACHING METHOD OF DIRECT COLOR PHOTOGRAPHY.

By A. BOSCH.

THE bleaching method of color photography consists in mixing aniline dyes with gelatine treated with peroxide of hydrogen. This mixture is poured on a ground glass plate. After drying, the plate is exposed either under a colored screen or direct to the object desired in a camera.

This method was discovered by Dr. Neuhauss of Berlin. It is possible that in the near future it will be perfected and lead to most excellent results. Dr. Neuhauss exhibited a number of colored copies before the two Berlin amateur unions in May this year, and in June before the Fifth International Congress for Applied Chemistry. Some of these photographs were 30 by 40 centimeters in size. A great advantage of this new method over the old is that the plates need not be exposed immediately after drying. They can be stored away and kept for any length of time, all that is necessary being a bath of ether and peroxide of hydrogen before exposing. A good recipe for setting the gelatine mixture is the following:

Soft gelatine emulsion (Eder)...	10 grammes
Distilled water	100 grammes

After melting the gelatine, add following mixture, at same time stirring steadily:

Methylene blue (1:500 in distilled water)	6 cubic centimeters
Auranine (1:500 in alcohol)	1.5 cubic centimeters
Erythrosine (1:200 in distilled water)	3 cubic centimeters

After mixing thoroughly, filter the mixture and pour onto the slightly warmed ground glass plate until a film of desired thickness is obtained. Then place plate upon an exactly horizontal marble slab and allow the contents to solidify. Place the plate in a drying apparatus and dry as quickly as possible—best by means of forced draft, the air having been previously warmed.

Dr. Neuhauss's drying apparatus is very ingenious. A dry plate box is provided with a small water turbine and a fan. In winter, however, a chimney draft is used. The box containing the plates is connected simply with the stove, the hot air being drawn through the box by force of chimney draft, drying the plates in about two hours. After drying, the plates can be kept for an indefinite length of time. If an exposure is desired, the plates are bathed for at least five minutes in an etheric solution of hydrogen peroxide, prepared by mixing 6 cubic centimeters of 30 per cent H_2O_2 with 200 cubic centimeters methyl ether. The undissolved H_2O_2 remains as a sediment in the bottle. After bathing the plates in this manner, they are quickly dried (ether facilitating drying).

For exposure under a colored slide or screen, it is advisable to rub both plate and slide with olive oil to prevent adhesion of the plates. The exposure of the plate under a screen to direct light varies from 10 to 15 minutes. The exposure can be accelerated by means of sensitizers, such as persulphate of ammonia, but at cost of beauty in reproduction of colors. Direct exposure to the sun's rays should be avoided as it causes the plate to dry out and lose its sensitivity. The plates are fixed with formalin, the pictures, however, becoming slightly yellowish thereby. The pictures are somewhat permanent without fixing. The exposure of the plate in a camera requires several hours and that with a lens of great light-transmitting power.

For a camera Dr. Neuhauss uses a box with a Voigtlaender portrait lens with 200 millimeters aperture f/2, 3, the sensitive plate being held in the rear end. At the time the writer visited the doctor, an exposure for a picture was being made. Twelve hours had then elapsed. By removing the cover of the camera, the progress of the exposure could be noted, the plate being very insensitive. The apparatus was protected against wind and rain by means of a few bricks and a cap of sheet zinc. Attempts to produce a colored positive directly in a camera have been pretty successful. Of course the whole process is yet in its infancy. The method has been taken up by the celebrated Lumière Brothers, of Lyons, and M. Seyewetz.

AN ARTIFICIAL RAIN.

INTO a cylindrical glass vessel, 4 inches in diameter and 8 inches high, pour alcohol of 82 deg., to about half the height of the glass. Cover the vessel with a porcelain saucer, immerse nearly to the top in a deep water bath, and cautiously apply heat, continuing the same until the entire vessel, with its contents and the saucer, acquires a high heat, but below the temperature of boiling alcohol. Remove from the bath as gently as possible, so as not to disturb the hot liquid any more than necessary, and set the vessel on a wooden table.

In a few minutes, or as soon as the saucer has begun to cool down, the alcohol fumes which fill the upper part of the vessel will begin to condense, and soon form visible clouds, just below the saucer. In a moment longer, the process of condensation will have reached a point when the liquefied alcohol begins to fall in a visible shower, straight downward to the surface of the still warm liquid. By using a microscope with, say, a 3-inch objective, and the tube arranged horizontally, these drops may be seen and even approximately measured, the diameter being from 40 to 50 mikrons (a mikron is one thousandth of a millimeter), some being a trifle larger and some even smaller than these figures. If care is used, this interesting spectacle may be made to last half an hour. At the commencement the vapors rise nearly to the under surface of the

saucer, but gradually sinking toward the level of the liquid as the vessel and its contents cool off, leaving a clear atmosphere above them as they descend.

This experiment places visibly before a class of school children, for instance, the whole phenomena of cloud formation, condensation and of rain, exactly as they occur in nature, with the single exception that the liquid is alcohol instead of water. Even the phenomena of the cyclone and of the rainbow may be introduced, the former by replacing the warm saucer with a cold one; and the latter by sending a beam of condensed light through the falling droplets.—Nat. Drug.

A UNIQUE COLOR AND PAINT CHEMICAL LABORATORY.*

There are probably few manufactures which call for the establishment of an experimental and research laboratory to such an extent as that of the color, paint, and cognate industries. Indeed, such an institution is indispensable since improvements in existing methods and the discovery of new processes are so continually coming to the front, together with the investigation of the various phenomena which constantly arise in all the ramifications of this extensive range of commerce. It is for this reason that the up-to-date technical and scientific research laboratory established at Aynsome, Grange over Sands, in Lancashire (Eng.), possesses such a unique interest, since it is the only institution of this description in England, and probably, owing to its complete equipment, stands preëminent among the similar institutions of its kind in other parts of the world.

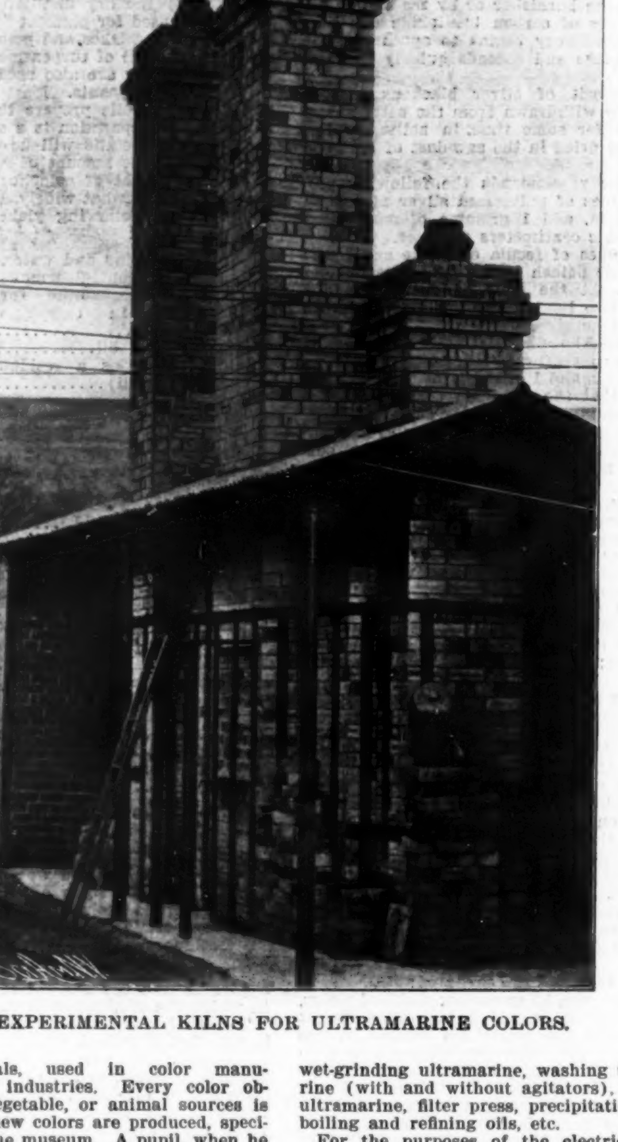
This laboratory, which also serves the dual purpose of a technical, or training school, owes its inception to Mr. J. Stewart Remington. For several years he was regarded as the leading expert analytical and consulting chemical adviser, not only among the principal color firms of the United Kingdom, but among the other allied trades, such as the cement and paper industries. While engaged in this work it occurred to him that considerable benefit might be bestowed, not only upon the particular trades in which he was specially concerned, but upon the rising generation, by the foundation of a laboratory replete with all modern contrivances, such as erecting plant, machinery, etc., for research in the color, varnish, oil, and kindred industries. The work accomplished at Aynsome is analytical, electrical, technological, and bacteriological. The primary objects of the institution are to educate pupils concerning the constitution, peculiarities, and functions of oils, varnishes, colors, etc., so that they may reduce to the concrete, and practice, the theories they advance, for the purpose of ascertaining their commercial utility and value. To achieve this purpose each student is taken thoroughly through three courses: Routine chemical work, special investigations, and practical manufacture.

The pupil thereby not only acquires a knowledge of the chemistry of colors, and the mere testing and valuation of the raw materials, but is carefully trained in the manufacture of the finished product. The result of such a curriculum is that he is not governed in his actions and processes by the obsolete simple rule-of-thumb methods which obtain by the ordinary graduation through a factory, but is in a position to think for himself, and able to prosecute his investigations independently and unfettered, in the confidence of a thorough and ultimate knowledge of the nature of the materials with which he is working.

Again, the laboratory is used for the analyzing and investigation of the work of other manufactories which do not possess their own facilities for such work, or cannot afford the time and expense therefor, in much the same manner in which a national physical laboratory acts toward other industries. Specimens of various raw products employed in color manufacture are submitted to rigorous examination to ascertain their value, and any difficulties with which the worker in another manufactory is confronted, are investigated and solved for him.

Furthermore, by means of the model color mill, the pupil is taught how to carry out the actual process of manufacturing any specific commodity at the minimum of cost and wastage; also thereby saving the time, expense, and trouble to a manufacturing firm, and enabling conclusive data to be obtained concerning the cost of making any new specialty for the market, from which the person for whom the investigation has been carried out can determine whether any profitable result can be obtained by his proceeding with the manufacture of the particular specialty.

The laboratory is an extensive building and is subdivided into various departments, wherein such functions as physical testing, color mixing, and so forth, are respectively carried out. One of the most interesting sections is the color collection department. This is to all intents and purposes an extensive museum and reference library, for here are arranged in methodical order a complete selection, numbering many hundreds in all, of specimens of mineral and aniline colors, raw products, oils, varnishes, gums, glues, wood extracts, and chemicals, used in color manufacture and the allied industries. Every color obtained from mineral, vegetable, or animal sources is here exhibited, and as new colors are produced, specimens are preserved in the museum. A pupil, when he enters the institution, is first rendered familiar with all the specimens here displayed. The characteristics, constituents, and the derivative process of each sample are carefully explained, so that the student can obtain a thorough acquaintance with the fundamental basis of his study.



EXPERIMENTAL KILNS FOR ULTRAMARINE COLORS.

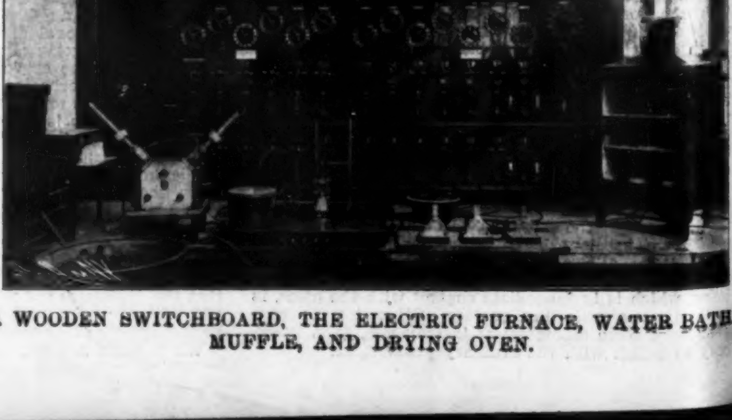
The principal laboratory is a spacious apartment measuring 40 feet in length by 24 feet in width, equipped with a modern plant, comprising chemical apparatus for all practical work, both quantitative, qualitative, volumetric, and advanced analyses. Here are carried out the examination of oils, greases, and lubricants, and the grinding of colors, both wet and dry. With regard to the former the important factors, such as the flash point, viscosity, the behavior toward friction, fluidity, and peculiarities are ascertained and duly noted. The plant for the satisfactory and successful accomplishment of this work comprises more especially a Thurston friction tester, a large stupper tester, Bailey's pendulum tester, the warm glass tester, refractometers, viscosity tests, etc.

In the color mill is a disintegrator, two edge-running dry mills, levigating mill, settling tanks, paint grinding mill, pug-mill, horizontal kneading and mixing machine, two triple roller mills, two stone mills for wet-grinding ultramarine, washing tanks for ultramarine (with and without agitators), settling tanks for ultramarine, filter press, precipitation paint plant for boiling and refining oils, etc.

For the purposes of the electrical experiments a useful electrical plant has been installed. The current is supplied from a compound dynamo generating 100 volts and 135 amperes, driven by belting from a 16-horsepower oil engine. The current is stored in a 55 cell, 220 ampere-hour accumulator, the current from the dynamo, over and above that required for charging the accumulators, being utilized as required for laboratory purposes, the current, when the engine is not in use, being drawn straight from the accumulators. At one end of the main chemical laboratory is a large electrical switchboard, provided with plug-and-line connections for the carrying out of the electrolytic tests relative to the determination of metals in mineral oils, paints, etc. There is also a furnace, a muffle or drying oven, a water kettle or hot bath, and hot plate, all operated by the electric current. In the engine and dynamo department are also two Faija cement testing machines, a bar testing plant, an oil tester, a one-horsepower electric motor,

* Specially prepared for the Scientific American Supplement.

THE INTERIOR OF THE COLOR MILL.

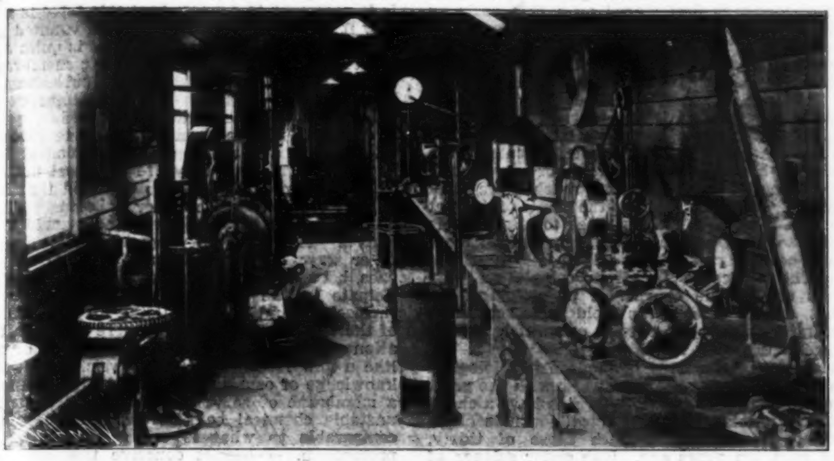


A WOODEN SWITCHBOARD, THE ELECTRIC FURNACE, WATER BATH MUFFLE, AND DRYING OVEN.

and two Schupper wood pulp testing machines for ascertaining the degree of moisture in wood pulp.

Extending off the main testing room is the balance room, which is equipped with numerous balances and a valuable scientific library of reference books. There is also a smaller laboratory replete with apparatus for bacteriological examinations and the analysis of water; and a three-cylinder mixing machine for experimental color work.

Small perfect experimental kilns have been erected



PHYSICAL TESTING ROOM.

for the manufacture of ultramarine, smalts, etc. These kilns also permit the carrying out of general crucible work. One, however, is reserved for the exclusive manufacture of ultramarine, for which special facilities have been made to admit of the determination of the temperature of the materials in the crucibles being ascertained at different stages of the process. Another kiln is utilized for the making of smalts, and two muffle kilns for the production of red lead. Ultramarine is for the most part imported into Great Britain, but it is hoped by the results of the work carried out at these Aynsome laboratories that it will be possible to carry out the manufacture of the product at home, upon a sufficiently large scale to render it commercially lucrative.

The examination of fibers and papers of various descriptions is also undertaken, the tests in this connection, apart from those of a chemical investigation nature, relating to materials employed, the determination of moisture, and other technical problems. Facilities are available for tests of the fibers up to fifteen atmospheres' pressure.

In the cement, clay working, and allied industrial departments, provisions are made for a wide range of tests. Investigations are carried out to ascertain the tensile strength, setting power, shrinkage, and other peculiarities, and physical properties of cements; a powerful electric furnace for testing the fusion point of clays, the analysis, color, hardness, durability, and suitability of clays for brick manufacture. Another important department is the metallurgical section for the analysis of iron, steel, ferrochrome, silicon, and other metals, etc.

All tests are carried out with rigorous secrecy. The samples and specimens submitted for investigation by other manufacturing firms are handed to the chemists, who have not the slightest idea of their ownership, so that the experiments are carried out with perfectly unprejudiced and unbiased minds and the results are conveyed to the owners confidentially, so that all possibility of leakage is obviated.

The laboratory has proved a remarkable success, and the results of the researches carried out have exercised a great beneficial influence upon the color and other allied industries of Great Britain, and have done much to enable that country to hold its present high position in this department of commerce.

ARTIFICIAL SILK—A PROBLEM IN CHEMICAL INVENTION.

The invention of artificial silk exemplifies strikingly how man has learned practically to apply the lessons taught by nature. It was Réaumur who first intelligently explained the methods employed by the silkworm in forming silk, and conceived the idea of accomplishing the same result artificially. Réaumur proved that silk was the product of certain glands located on the underside of the body of the worm. The larger portion of the albumen of the silkworm's nourishment is transformed into fibroin and secreted in the glands. Eventually the weight of these glands becomes equal to about a third of that of the entire body. If they be opened, a silky substance will be found contained within them in a semi-liquid mass. It was, therefore, very natural that Réaumur should have propounded the question whether it would not be possible to spin out other semi-liquid substances, as, for example, certain varieties of pitch, into thin threads and thus produce artificially a silk-like substance equally as serviceable as the fibroin of the silkworm.

Réaumur's time was undoubtedly ripe for theoretical discussion but it was not ripe for the purpose of overcoming the technical obstacles presented. It was not until one hundred and fifty years had elapsed before sufficient experience was gained wherewith the solution of the problem could be commenced.

Silk fiber is distinguished from all other fibers by the circumstance that it is not built up of cells, but constitutes a congealed fluid stream. This stream is produced by the silkworm, by discharging the contents of its glands through minute openings. As it comes into contact with the air the silky substance solidifies, thus producing a thread which can be continuously spun on until the gland is exhausted. If the same result is to be produced by the means at our disposal, it would be necessary merely to discharge a suitable fluid from its containing receptacle through a very fine outlet. We should then reproduce the exact process carried out by the silkworm, and we should then form silk. But at this stage obstacles are encountered, which Réaumur, although he did not clearly recognize them, still suspected their existence. To use his own words: "It will be impossible to produce as fine threads as are produced by the silkworm, but it should not be impossible to spin out varnishes into threads of sufficient fineness." In this statement the great technical difficulties of the problem are clearly indicated.

That a fluid stream can be congealed can hardly be doubted; but the task consists in ejecting a stream of sufficiently small diameter. A stream is produced because every fluid has a definite cohesion. But fluids are subjected to the laws of another force besides that of cohesion, and this force is the force of superficial tension, according to which every fluid constantly tends to assume the form that will most uniformly occupy space. This form is a globe. The greater the mass of the fluid, the greater will be the cohesion; the smaller the mass the greater will be the superficial tension. For this reason every fluid stream, which is nothing more nor less than a cylinder of infinite length, will tend to divide itself into drops, that is, into individual globules. The finer the stream, the greater will be the tendency to produce globules. When streams of extreme fineness are produced it is not possible to prevent the formation of globules. Careful observation of a stream of water emerging from a pipe will prove that, as the stream becomes finer, a ring-like furrow will be produced, which gradually approaches the pipe outlet and disappears in a drop.

The superficial tension must overcome the cohesion, and the cohesion varies with different fluids. For this reason some fluids are particularly well adapted for the formation of drops. The resistance which a fluid opposes to the tendency to form drops is called its viscosity. Fluids which have a very low viscosity such as ether, can hardly be made to form a connected stream. On the other hand, very viscous fluids are not easily separated into drops. It, therefore, follows, that it would not be possible to produce artificial silk from every congealable fluid; but that it would be necessary to employ a viscous fluid which, as it is ejected from a fine opening, will form a continuous stream.

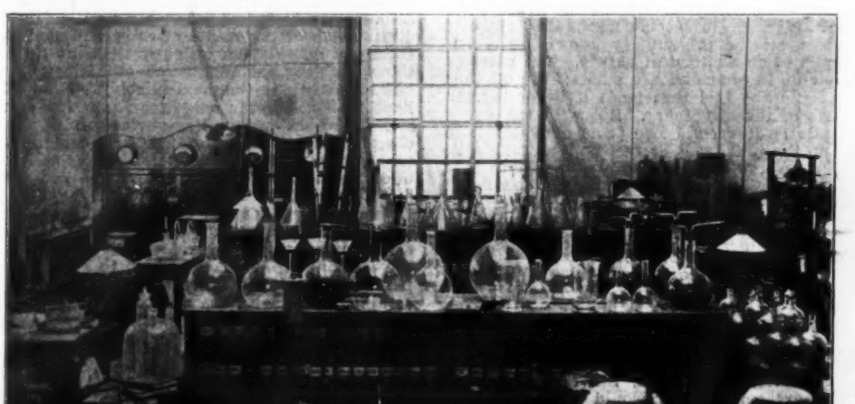
A beautiful example of the utilization of physical processes in producing artificial silk is offered by the manufacture of shot. Most metals in their molten condition, despite their high specific gravity, have a low viscosity. A stream of metal, therefore, is easily separated into individual drops which solidify as they cool off. Mercury is an admirable example of a metal of small viscosity but of enormous superficial tension. If molten lead be poured through a sieve rotated on top of a tower, the streams of fluid metal immediately separate into drops which are congealed and solidify before they reach the bottom. A large number of round balls of lead, in other words, shot, is the result. The opposite of that which occurs when lead and mercury streams are separated into drops must be accomplished by the fluid which is to yield artificial silk. In other words, the fluid must be viscous. But since viscous fluids flow slowly, and since superficial tension is overcome by causing the particles of the fluid to move forward in the given direction, it is not enough simply to press the fluid out of an opening in order to form streams of sufficient fineness. The superficial tension would simply lead to the formation of drops. This can be proved by pouring a solution of rubber, which is very viscous, into a vessel provided with a very small hole. Out of this hole there would emerge not a stream, the diameter of which would correspond with that of the hole, but thick drops which cling to the vessel. If the hole be fine enough, this drop may congeal through vaporization, thereby closing the hole and preventing the egress of further drops. A fluid of lower viscosity, such as water, would flow out of the vessel in a short time in a fine stream.

In order to allow viscous fluids to flow out of the vessel in a fine stream, the pressure of the fluid must be in some way increased. This can be done by assisting the pressure with suction. If the drop of rubber had been touched with the finger at the moment when it was formed, and the finger then withdrawn, the rubber solution would have followed in the form of a fine thread. This is the process employed by the confectioner in spinning taffy or candy. And this is also the process employed by the silkworm in spinning silk. For the creature secures the first drop which emerges from the glands to some object, and assists the natural pressure of the substance by moving its head hither and thither. Such is the process which must be employed if man wishes to produce artificial silk when he has found the proper material.

So far the difficulties have been indicated which had to be overcome before the manufacture of artificial silk became a reality. Only an empiricist, who would never think of the scientific analysis of such difficulties, would have the courage to attempt to overcome them.

This empiricist, whose work has hardly as yet received sufficient recognition, was a French aristocrat, Count Hilaire de Chardonnet, who attempted to make artificial silk at the beginning of the eighties. His product was first exhibited to the world at the Paris Exposition of 1889. So astonished were those who had never thought it possible that human ingenuity could imitate nature, that many believed that genuine natural silk was exhibited and not artificial silk. One American silk maker was even ready to take his oath that the artificial silk produced was natural silk.

The substance which Chardonnet selected for the production of artificial silk was collodion, which, as everyone knows, is a solution of gun cotton in alcohol and ether. This liquid is slimy and tends to solidify after volatilization, leaving the gun cotton behind in the form of a glossy residue. By means of a spinning machine Chardonnet spun out this product, imitating the methods of the silkworm. Collodion was expressed from fine openings constituted by glass tubes of very small diameter. The viscous material as it emerged first formed a drop which was seized and spun out into a thread. As soon as this drop had been formed and secured to a bobbin, the liquid followed in a continuous stream. By turning the bobbin quickly threads were formed which were much smaller in diameter than the one-half millimeter diameter of the opening. Since the collodion did not solidify quickly enough by volatilization alone, Chardonnet caused the thread to pass



INTERIOR OF LARGER CHEMICAL LABORATORY.

through water, which as soon as it rid the collodion of its solvent caused the thread to solidify. Later he added water to the collodion and was enabled to spin his thread directly in the air.

But the difficulties which the founder of the artificial silk industry had to overcome, were by no means exhausted. Gun cotton is a very combustible substance. Clothes could never have been made of artificial silk, for they would have burst into flames upon

touching a spark. Therefore, it became necessary to render gun cotton, after it had been spun, more incombustible and refractory. In the beginning, Chardonnet tried to accomplish this result by means of metallic salts added to the solution. Later he adopted the more convenient plan of changing the nitro-cellulose of the spun silk back into ordinary and, therefore, less combustible cellulose, by means of suitable reagents. Artificial silk, as it is now made, is no more nor less dangerous than cotton or the paper fiber out of which it is made.

Collodion is, of course, not the only substance which can be spun out. Almost any liquid of sufficient viscosity would lend itself to the purpose. Up to the present, however, only such fluids have been used which after solidification can be transformed into cellulose. For that reason the number of liquids which can be employed is necessarily limited. One of the fluids which has been utilized as a substitute for collodion is ammonium copper oxid. A solution of cellulose in this chemical is found to possess the necessary viscosity. By the addition of a weak solution of sulphuric acid cellulose is immediately precipitated. In this manner a thread of silk can be produced.

The manufacture of viscose silk is just as ingenious. The method, of course, is based upon the principle that cellulose, by treatment with caustic soda and bisulphide of carbon can be transformed into a substance which by reason of its peculiar consistency has received the name "Viscose." By spinning this liquid in a solution of sal ammoniac threads are produced, which after drying under tension are spontaneously retransformed into cellulose consisting of silk-like fibers.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

THE PRESENT POSITION OF CHEMICAL PHYSIOLOGY.*

AN engineer who desires to thoroughly understand how a machine works must necessarily know its construction. If the machine becomes erratic in its action, and he wishes to put it into proper working order, a preliminary acquaintance with its normal structure and function is an obvious necessity.

If we apply this to the more delicate machinery of the animal body, we at once see how a knowledge of function (physiology and pathology) is impossible without a preliminary acquaintance with structure or anatomy.

It is therefore not surprising, it is indeed in the nature of things, that physiology originated with the great anatomists of the past. It was not until Vesalius and Harvey by tedious dissections laid bare the broad facts of structure, that any theorizing concerning the uses of the constituent organs of the body had any firm foundation.

Important and essential as the knowledge is that can be revealed by the scalpel, the introduction and use of the microscope furnished physiologists with a still more valuable instrument. By it much that was before unseen came into view, and microscopic anatomy and physiology grew in stature and knowledge simultaneously.

The weapons in the armory of the modern physiologist are multitudinous in number and complex in construction, and enable him in the experimental investigation of his subject to accurately measure and record the workings of the different parts of the machinery he has to study. But pre-eminent among these instruments stands the test-tube and the chemical operations typified by that simple piece of glass.

Herein one sees at once a striking distinction between the mechanism of a living animal and that of a machine like a steam engine or a watch. It is quite possible to be an excellent watchmaker or to drive a steam engine intelligently without any chemical knowledge of the various metals that enter into its composition. In order to set the mechanism right if it goes wrong, all the preliminary knowledge which is necessary is of an anatomical nature. The parts of which an engine is composed are stable; the oil that lubricates it and the fuel that feeds it never become integral parts of the machinery. But with the living engine all this is different. The parts of which it is made take up the nutriment or fuel and assimilate it, thus building up new living substance to replace that which is destroyed in the wear and tear associated with activity. This condition of unstable chemical equilibrium is usually designated metabolism, and metabolism is the great and essential attribute of a living as compared with a non-living thing.

It seems childish at the present day, and before such an audience as this, to point out how essential it is to know the chemical structure as well as the anatomical structure of the component parts of the body. But the early anatomists to whom I have alluded had no conception of the connection of the two sciences. Speaking of Vesalius, Sir Michael Foster says: "The great anatomist would no doubt have made use of his bitterest sarcasms had some one assured him that the fantastic school which was busy with occult secrets and had hopes of turning dross into gold would one day join hands in the investigation of the problems of life with the exact and clear anatomy so dear to him." Nor did Harvey, any more than Vesalius, pay heed to chemical learning. The scientific men of his time ignored and despised the beginning of that chemical knowledge which in later years was to become one of the foundations of physiology and the mainstay of the art of medicine.

The earliest to recognize this important connection was one whose name is usually associated more with charlatanry than with truth, namely, Paracelsus, and fifty years after the death of that remarkable and curious personality his doctrines were extended and developed by Van Helmont. In spite, however, of Van Helmont's remarkable insight into the processes of digestion and fermentation, his work was marred by the mysticism of the day, which called in the aid of supernatural agencies to explain what could not otherwise be fully comprehended.

In the two hundred and fifty years that have intervened between the death of Van Helmont and the present day, alchemy became a more and more exact science and changed its name to chemistry, and a few striking names stand out of men who were able to take the new facts of chemistry and apply them to physiological uses. Of these one may mention Mayow, Lower, Boerhaave, Réaumur, Borelli, Spallanzani and Lavoisier. Mulder in Holland and Liebig in Germany bring us almost to the present time, and I think they may be said to share the honor of being regarded as the fathers of modern chemical physiology. This branch of science was first placed on a firm basis by Wöhler when he showed that organic compounds can be built out of their elements in the laboratory, and his first successful experiments in connection with the comparatively simple substance, urea, have been followed by numberless others, which have made organic chemistry the vast subject it is to-day.

Sir Michael Foster's book on the History of Physiology, from which I have already quoted, treats of the older workers who laid the foundations of our science, and whose names I have not done much more than barely mention. Those interested in the giants of the past should consult it. But what I propose to take up this morning is the work of those who have during more recent days been engaged in the later stages of the building. The edifice is far from completion even now. It is one of the charms of physiological endeavor that, as the older areas yield their secrets to the explorers, new ones are opened out which require equally careful investigation.

If even a superficial survey of modern physiological literature is taken, one is at once struck with the great preponderance of papers and books which have a chemical bearing. In this the physiological journals of to-day contrast very markedly with those of thirty, twenty, or even ten years ago. The sister science of chemical pathology is making similar rapid strides. In some universities the importance of biological chemistry is recognized by the foundation of chairs which deal with that subject alone; and though in the United Kingdom, owing mainly to lack of funds, this aspect of the advance of science is not very evident, there are signs that the date cannot be far distant when every well-equipped university or university college will follow the example set us at many seats of learning on the Continent and at Liverpool.

With these introductory remarks, let me now proceed to describe what appear to me to be the main features of chemical physiology at the present time.

The first point to which I shall direct your attention is the rapid way in which chemical physiology is becoming an exact science. Though it is less than twenty years since I began to teach physiology, I can remember perfectly well a time when those who devoted their work to the chemical side of the science might almost be counted on the fingers of one hand, and when chemists looked with scarcely veiled contempt on what was at that time called physiological chemistry; they stated that physiologists dealt with messes or impure materials, and therefore anything in the nature of correct knowledge was not possible. There was a good deal of truth in these statements, and if physiologists to-day cannot quite say that they have changed all that, they can at any rate assert with truth that they are changing it. This is due to a growing *rapprochement* between chemists and physiologists. Many of our younger physiologists now go through a thorough preliminary chemical training; and on the other hand there is a growing number of chemists—of whom Emil Fischer may be taken as a type—who are beginning to recognize the importance of a systematic study of substances of physiological interest. A very striking instance of this is seen in the progress of our knowledge of the carbohydrates, which has culminated in the actual synthesis of several members of the sugar group. Another instance is seen in the accurate information we now possess of the constitution of uric acid. When Miescher began his work on the chemical composition of the nuclei of cells, and separated from them the material he called nuclein, he little foresaw the wide practical application of his work. We now know that it is in the metabolism of cell-nuclei that we have to look for the oxidative formation of uric acid and other substances of the purine family. Already the chemical relationships of uric acid and nuclein have taught practical physicians some of the secrets that underlie the occurrence of gout and allied disorders.

With the time at my disposal, it would be impossible to discuss all the chemico-vital problems which the physiologists of the present day are attempting to solve, but there is one subject at which many of them are laboring which seems to me to be of supreme importance—I mean the chemical constitution of proteid or albuminous substances. Proteids are produced only in the living laboratory of plants and animals; proteid metabolism is the main chemical attribute of a living thing; proteid matter is the all-important material present in protoplasm. But in spite of the overwhelming importance of the subject, chemists and physiologists alike have far too long fought shy of attempting to unravel the constitution of the proteid molecule. This molecule is the most complex that is known; it always contains five, and often six, or even seven elements. The task of thoroughly understanding its composition is necessarily vast, and advance slow. But little by little the puzzle is being solved, and this final conquest of organic chemistry, when it does arrive, will furnish physiologists with new light on many of the dark places of physiological science.

The revival of the vitalistic conception in physiological work appears to me a retrograde step. To explain anything we are not fully able to understand in the light of physics and chemistry by labeling it as vital or something we can never hope to understand is a confession of ignorance, and, what is still more harmful, a bar to progress. It may be that there is a special force in living things that distinguishes them from the inorganic world. If this is so, the laws that regulate this force must be discovered and measured, and I have no doubt that those laws, when discovered, will be found to be as immutable and regular as the force of gravitation. I am, however, hopeful that the scientific workers of the future will discover that this so-called vital force is due to certain physical or chemical properties of living matter which have not yet been brought into line with the known chemical and physical laws that operate in the inorganic world, but which as our knowledge of chemistry and physics increases, will ultimately be found to be subservient to such laws.

Let me take as an example the subject of osmosis. The laws which regulate this phenomenon through dead membranes are fairly well known and can be experimentally verified; but in the living body there is some other manifestation of force which operates in such a way as to neutralize the known force of osmosis. Is it necessary to suppose that this force is a new one? May it not rather be that our much vaunted knowledge of osmosis is not yet complete? It is quite easy to understand why a dead and a living membrane should behave differently in relation to substances that are passing through them. The molecules of the dead membrane are, comparatively speaking, passive and stable; the molecules in a membrane made of living cells are in a constant state of chemical integration and disintegration; they are the most unstable molecules we know. Is it to be expected that such molecules would allow water, or substances dissolved in water, to pass between them and remain entirely inactive? The probability appears to me to be all the other way; the substances passing, or attempting to pass, between the molecules will be called upon to participate in the chemical activities of the molecules themselves, and in the building up and breaking down of the compounds so formed there will be a transformation of chemical energy and a liberation of what looks like a new force. Before a physicist decides that his knowledge of osmosis is final, let him attempt to make a membrane of some material which is in a state of unstable chemical equilibrium, a state in some way comparable to what is called metabolism in living protoplasm. I cannot conceive that such a task is insuperable, and when accomplished, and the behavior of such a membrane as an osmometer or dialyzer is studied, I am convinced that we shall find that the laws of osmosis as formulated for such dead substances as we have hitherto used will be found to require revision.

Such an attitude in reference to vital problems appears to be infinitely preferable to that which too many adopt of passive content, saying the phenomenon is vital and there is an end of it.

When a scientific man says this or that vital phenomenon cannot be explained by the laws of chemistry and physics, and therefore must be regulated by laws of some other nature, he most unjustly assumes that the laws of chemistry and physics have all been discovered. He forgets, for instance, that such an important detail as the constitution of the proteid molecule has still to be made out.

The recent history of science gives an emphatic denial to such a supposition. All my listeners have within the last few years seen the discovery of the Röntgen rays and the modern development of wireless telegraphy. On the chemical side we have witnessed the discovery of new elements in the atmosphere and the introduction of an entirely new branch of chemistry called physical chemistry. With such examples ready to our hands, who can say what further discoveries will not shortly be made, even in such well worked fields as chemistry and physics?

The mention of physical chemistry brings me to what I may term the second head of my discourse, the second striking characteristic of modern chemical physiology; this is the increasing importance which physiologists recognize in a study of inorganic chemistry. The materials of which our bodies are composed are mainly organic compounds, among which the proteids stand out as pre-eminently important; but everyone knows there are many substances of the mineral or inorganic kingdom present in addition. I need hardly mention the importance of water, of the oxygen of the air, and of salts like sodium chloride and calcium phosphate.

The new branch of inorganic chemistry called physical chemistry has given us entirely new ideas of the nature of solutions, and the fact that electrolytes in solution are broken up into their constituent ions is one of fundamental importance. One of the many physiological aspects of this subject is seen in a study of the action of mineral salts in solution on living organisms and parts of organisms. Many years ago Dr. Ringer showed that contractile tissues (heart, cilia, etc.) continue to manifest their activity in certain saline solutions. Howell goes so far as to say, and probably correctly say, that the cause of the rhythmical action of the heart is the presence of these inorganic substances in the blood or lymph which usually bathes it. The subject has more recently been taken up by Loeb and his colleagues at Chicago; they confirm Ringer's original statements, but interpret them now as ionic action. Contractile tissues will not contract in pure solutions of non-electrolytes like sugar or albumen. But different contractile tissues differ in the nature of the ions which are their most favorable stimuli. An optimum salt solution is one in which stimulating ions, like those of sodium, are mixed with a certain small amount of those which, like calcium, restrain activity. Loeb considers that the ions act because they affect either the physical condition of the colloidal substances (proteid, etc.) in protoplasm or the rapidity of chemical processes.

Amœboid movement, ciliary movement, the contraction of muscle, cell division, and karyokinesis all fall into the same category as being mainly dependent on the stimulating action of ions.

Loeb has even gone so far as to consider that the process of fertilization is mainly ionic action; he denies that the nuclein of the male cell is essential, but asserts that all it does is to act as the stimulus in the due adjustment of the proportions of the surrounding ions, and supports this view by numerous experiments on ova in which, without the presence of spermatozoa, he has produced larvæ by merely altering the saline constituents and so the osmotic pressure of the fluid that surrounds them. Whether such a sweeping and almost revolutionary notion will stand the test of further verification must be left to the future; so also must the equally important idea that nervous impulses are to be mainly explained on an electrolytic basis. But whether or not all the details of such work will

* Opening Address by W. D. Halliburton, M. D., F.R.S., Professor of Physiology in King's College, London, President of the Section.

stand the test of time, the experiments I have briefly alluded to are sufficient to show the importance of physical chemistry to the physiologist, and they also form a useful commentary on what I was saying just now about vitalism. Such eminently vital phenomena as movement and fertilization are to be explained in whole or in part as due to the physical action of inorganic substances. Are not such suggestions indications of the undesirability of postulating the existence of any special mystic vital force?

I have spoken up to this point of physical chemistry as a branch of inorganic chemistry; there are already indications of its importance also in relation to organic chemistry. Many eminent chemists consider that the future advance of organic chemistry will be on the new physical lines. It is impossible to forecast where this will lead us; suffice it to say that not only physiology, but also pathology, pharmacology, and even therapeutics will receive new accessions to knowledge the importance of which will be enormous.

I have now briefly sketched what appear to me to be the two main features of the chemical physiology of to-day, and the two lines, organic and inorganic, along which I believe it will progress in the future.

Let me now press upon you the importance in physiology, as in all experimental sciences, of the necessity first of bold experimentation, and secondly, of bold theorizing from experimental data. Without experiment all theorizing is futile; the discovery of gravitation would never have seen the light if laborious years of work had not convinced Newton that it could be deduced from his observations. The Darwinian theory was similarly based upon data and experiments which occupied the greater part of its author's lifetime to collect and perform. Pasteur in France and Virchow in Germany supply other instances of the same devotion to work which was followed by the promulgation of wide-sweeping generalizations.

And, after all, it is the general law which is the main object of research; isolated facts may be interesting and are often of value, but it is not until facts are correlated and the discoverers ascertain their interrelationships that anything of epoch-making importance is given to the world.

It is, however, frequently the case that a thinker with keen insight can see the general law even before the facts upon which it rests are fully worked out. Often such bold theorizers are right, but even if they ultimately turn out to be wrong, or only partly right, they have given to their fellows some general idea on which to work; if the general idea is incorrect, it is important to prove it to be so in order to discover what is right later on. No one has ever seen an atom or a molecule, yet who can doubt that the atomic theory is the sheet anchor of chemistry? Mendeléeff formulated his periodic law before many of the elements were discovered; yet the accuracy of this great generalization has been such that it has actually led to the discovery of some of the missing elements.

I purpose to illustrate these general remarks by a brief allusion to two typical sets of researches carried out during recent years in the region of chemical physiology. I do not pretend that either of them has the same overwhelming importance as the great discoveries I have alluded to, but I am inclined to think that one of them comes very near to that standard. The investigations in question are those of Ehrlich and of Pawlow. The work of Ehrlich mainly illustrates the useful part played by bold theorizing, the work of Pawlow that played by the introduction of new and bold methods of experiment.

I will take Pawlow first. This energetic and original Russian physiologist has, by his new methods, succeeded in throwing an entirely new light on the processes of digestion. Ingeniously devised surgical operations have enabled him to obtain the various digestive juices in a state of absolute purity and in large quantity. Their composition and their actions on the various foodstuffs have thus been ascertained in a manner never before accomplished; an apparently unfailing resourcefulness in devising and adapting experimental methods has enabled him and his fellow workers to discover the paths of the various nerve impulses by which secretion in the alimentary canal is regulated and controlled. The importance of the physical element in the process of digestion has been experimentally verified. If I were asked to point out what I considered to be the most important outcome of all this painstaking work, I should begin my answer by a number of negatives and would say, not the discovery of the secretory nerves of the stomach or pancreas; not the correct analysis of the gastric juice, nor the fact that the intestinal juice has most useful digestive functions; all of these are discoveries of which any one might have been rightly proud; but after all they are more or less isolated facts. The main thing that Pawlow has shown is that digestion is not a succession of isolated acts, but each one is related to its predecessor and to that which follows it; the process of digestion is thus a continuous whole; for example, the acidity of the gastric juice provides for a delivery of pancreatic juice in proper quantity into the intestine; the intestinal juice acts upon the pancreatic, and so enables the latter to perform its powerful actions. I am afraid this example, as I have tersely stated it, presents the subject rather inadequately, but it will serve to show what I mean. Further, the composition of the various juices is admirably adjusted to the needs of the organism; when there is much proteid to be digested, the proteolytic activity of the juices secreted is correspondingly high, and the same is true for the other constituents of the food. It is such general conclusions as these, the correlation of isolated facts leading to the formulation of the law that the digestive process is continuous in the sense I have indicated, and adapted to the needs of the work to be done, that constitute the great value of the work from the Russian laboratory. Work of this sort is sure to stimulate others to fill in the gaps and complete the picture, and already has borne fruit in this direction. It has, for instance, in Starling's hands, led to the discovery of a chemical stimulus to pancreatic secretion. This is formed in the intestine as the result of the action of the gastric acid, and taken by the blood-stream to the pancreas. Whether this *secretin*, as it is called, may be one of a group of similar chemical stimuli which operate in other parts of the body has still to be found out.

The other series of researches to which I referred are those of Ehrlich and his colleagues and followers on the subject of immunity. This subject is one of such importance to every one of us that I am inclined to place the discovery on a level with those great discoveries of natural laws to which I alluded at the outset of this portion of my address. I hesitate to do so yet because many of the details of the theory still await verification. But up to the present all is working in that direction, and Ehrlich's ideas illustrate the value of bold theorizing in the hands of clear-sighted and far-seeing individuals.

But when I say that the doctrine is bold, I do not mean to infer that the experimental facts are scanty; they are just the reverse. But in the same way that a chemist has never seen an atom, and yet he believes atoms exist, so no one has yet ever seen a toxin or antitoxin in a state of purity, and yet we know they exist, and this knowledge promises to be of incalculable benefit to suffering humanity.

It may not be uninteresting to state briefly, for the benefit of those to whom the subject is new, the main facts and an outline of the theory which is based upon them.

We are all aware that one attack of many infective maladies protects us against another attack of the same disease. The person is said to be *immune* either partially or completely against that disease. Vaccination produces in a patient an attack of cow-pox or vaccinia. This disease is related to smallpox, and some still hold that it is small-pox modified and rendered less malignant by passing through the body of a calf. At any rate, an attack of vaccinia renders a person immune to small-pox, or variola, for a certain number of years. Vaccination is an instance of what is called *protective inoculation*, which is now practised with more or less success in reference to other diseases like plague and typhoid fever. The study of immunity has also rendered possible what may be called *curative inoculation*, or the injection of antitoxic material as a cure for diphtheria, tetanus, snake poisoning, etc.

The power the blood possesses of slaying bacteria was first discovered when the effort was made to grow various kinds of bacteria in it; it was looked upon as probable that blood would prove a suitable soil or medium for this purpose. It was found in some instances to have exactly the opposite effect. The chemical characters of the substances which kill the bacteria are not fully known; indeed, the same is true for most of the substances we have to speak of in this connection. Absence of knowledge on this particular point has not, however, prevented important discoveries from being made.

So far as is known at present, the substances in question are proteid in nature. The bactericidal powers of blood are destroyed by heating it for an hour to 56 deg. C. Whether the substances are enzymes is a disputed point. So also is the question whether they are derived from the leucocytes; the balance of evidence appears to me to be in favor of this view in many cases at any rate, and phagocytosis becomes more intelligible if this view is accepted. The substances, whatever be their source or their chemical nature, are sometimes called alexins, but the more usual name now applied to them is that of *bacteriolysins*.

Closely allied to the bactericidal power of blood, or blood-serum, is its globulicidal power. By this one means that the blood-serum of one animal has the power of dissolving the red blood-corpuscles of another species. If the serum of one animal is injected into the bloodstream of an animal of another species, the result is a destruction of its red corpuscles, which may be so excessive as to lead to the passing of the liberated hæmoglobin into the urine (hæmoglobinuria). The substance or substances in the serum that possess this property are called *hæmolysins*, and though there is some doubt whether bacteriolysins and hæmolysins are absolutely identical, there is no doubt that they are closely related substances.

Another interesting chemical point in this connection is the fact that the bactericidal power of the blood is closely related to its alkalinity. Increase of alkalinity means increase of bactericidal power. Venous blood contains more diffusible alkali than arterial blood and is more bactericidal; dropsical effusions are more alkaline than normal lymph and kill bacteria more easily. In a condition like diabetes, when the blood is less alkaline than it should be, the susceptibility to infectious diseases is increased. Alkalinity is probably beneficial because it favors those oxidative processes in the cells of the body which are so essential for the maintenance of healthy life.

Normal blood possesses a certain amount of substances which are inimical to the life of our bacterial foes. But suppose a person gets run down; every one knows he is then liable to "catch anything." This coincides with a diminution in the bactericidal power of his blood. But even a perfectly healthy person has not an unlimited supply of bacteriolysin, and if the bacteria are sufficiently numerous he will fall a victim to the disease they produce. Here, however, comes in the remarkable part of the defense. In the struggle he will produce more and more bacteriolysin, and if he gets well it means that the bacteria are finally vanquished, and his blood remains rich in the particular bacteriolysin he has produced, and so will render him immune to further attacks from that particular species of bacterium. Every bacterium seems to cause the development of a specific bacteriolysin.

Immunity can more conveniently be produced gradually in animals, and this applies, not only to the bacteria, but also to the toxins they form. If, for instance, the bacilli which produce diphtheria are grown in a suitable medium, they produce the diphtheria poison, or toxin, much in the same way that yeast-cells will produce alcohol when grown in a solution of sugar. Diphtheria toxin is associated with a proteose, as is also the case with the poison of snake venom. If a certain small dose called a "lethal dose" is injected into a guinea-pig, the result is death. But if the guinea-pig receives a smaller dose it will recover; a few days after, it will stand a rather larger dose; and this may be continued until, after many successive gradually increasing doses, it will finally stand an amount equal to many lethal doses without any ill effects. The gradual introduction of the toxin has called forth the production of an antitoxin. If this is done in the horse instead of the guinea-pig the production of antitoxin is still more marked, and the serum obtained from the blood of an immunized horse may be used for injecting into human beings suffering from diphtheria, and rapidly cures the disease. The two actions of the blood, antitoxic and antibacterial, are frequently associated, but may be entirely distinct.

The antitoxin is also a proteid probably of the nature of a globulin; at any rate, it is a proteid of larger molecular weight than a proteose. This suggests a practical point. In the case of snake-bite the poison gets into the blood rapidly owing to the comparative ease with which it diffuses, and so it is quickly carried all over the body. In treatment with the antitoxin or antivenin, speed is everything if life is to be saved; injection of this material under the skin is not much good, for the diffusion into the blood is too slow. It should be injected straight away into a blood-vessel.

There is no doubt that in these cases the antitoxin neutralizes the toxin much in the same way that an acid neutralizes an alkali. If the toxin and antitoxin are mixed in a test tube and time allowed for the interaction to occur, the result is an innocuous mixture. The toxin, however, is merely neutralized, not destroyed; for if the mixture in the test tube is heated to 68 deg. C. the antitoxin is coagulated and destroyed and the toxin remains as poisonous as ever.

Immunity is distinguished into *active* and *passive*. Active immunity is produced by the development of protective substances in the body; passive immunity by the injection of a protective serum. Of the two the former is the more permanent.

Ricin, the poisonous proteid of castor-oil seeds, and *abrin*, that of the Jequirity bean, also produce, when gradually given to animals, an immunity, due to the production of antiricin and antiabrin respectively.

Ehrlich's hypothesis to explain such facts is usually spoken of as the *side-chain theory* of immunity. He considers that the toxins are capable of uniting with the protoplasm of living cells by possessing groups of atoms like those by which nutritive proteids are united to cells during normal assimilation. He terms these *haptophor* groups, and the groups to which these are attached in the cells he terms *receptor* groups. The introduction of a toxin stimulates an excessive production of receptors, which are finally thrown out into the circulation, and the free circulating receptors constitute the antitoxin. The comparison of the process to assimilation is justified by the fact that non-toxic substances like milk, introduced gradually by successive doses into the blood-stream, cause the formation of anti-substances capable of coagulating them.

Up to this point I have spoken only of the blood, but month by month workers are bringing forward evidence to show that other cells of the body may by similar measures be rendered capable of producing a corresponding protective mechanism.

One further development of the theory I must mention. At least two different substances are necessary to render a serum bactericidal or globulicidal. The bacteriolysin or hæmolysin consists of these two substances. One of these is called the *immune body*, the other the *complement*. We may illustrate the use of these terms by an example. The repeated injection of the blood of one animal (e. g. the goat) into the blood of another animal (e. g. the sheep) after a time renders the latter animal immune to further injections, and at the same time causes the production of a serum which dissolves readily the red blood-corpuscles of the first animal. The sheep's serum is thus hæmolytic toward goat's blood-corpuscles. This power is destroyed by heating to 56 deg. C. for half an hour, but returns when fresh goat's serum is added. The specific immunizing substance formed in the sheep is called the immune body; the ferment-like substance destroyed by heat is the complement. The latter is not specific, since it is furnished by the blood of non-immunized animals, but it is nevertheless essential for hæmolysis. Ehrlich believes that the immune body has two side groups—one which connects with the receptor of the red corpuscles and one which unites with the haptophor group of the complement, and thus renders possible the ferment-like action of the complement on the red corpuscles. Various antibacterial serums which have not been the success in treating disease they were expected to be are probably too poor in complement, though they may contain plenty of the immune body.

Quite distinct from the bactericidal, globulicidal and antitoxic properties of blood is its agglutinating action. This is another result of infection with many kinds of bacteria or their toxins. The blood acquires the property of rendering immobile and clumping together the specific bacteria used in the infection. The test applied to the blood in cases of typhoid fever, and generally called Widal's reaction, depends on this fact.

The substances that produce this effect are called *agglutinins*. They also are probably proteid-like in nature, but are more resistant to heat than the lysins. Prolonged heating to over 60 deg. C. is necessary to destroy their activity.

Lastly, we come to a question which more directly appeals to the physiologist than the preceding, because experiments in relation to immunity have furnished us with what has hitherto been lacking, a means of distinguishing human blood from the blood of other animals.

The discovery was made by Tchistovitch (1899), and his original experiment was as follows: Rabbits, dogs, goats and guinea-pigs were inoculated with eel-serum, which is toxic; he thereby obtained from these animals an antitoxic serum. But the serum was not only antitoxic, but produced a precipitate when added to eel-serum, but not when added to the serum of any other animal. In other words, not only has a specific antitoxin been produced, but also a specific *precipitin*. Numerous observers have since found that this is a

general rule throughout the animal kingdom, including man. If, for instance, a rabbit is treated with human blood, the serum ultimately obtained from the rabbit contains a specific precipitin for human blood; that is to say, a precipitate is formed on adding such a rabbit's serum to human blood, but not when added to the blood of any other animal.* The great value of the test is its delicacy; it will detect the specific blood when it is greatly diluted, after it has been dried for weeks, or even when it is mixed with the blood of other animals.

I have entered into this subject at some length, because it so admirably illustrates the kind of research which is now in progress; it is also of interest to others than mere physiologists. I have not by any means exhausted the subject, but for fear I may exhaust my audience let me hasten to a conclusion. I began by eulogizing the progress of the branch of science on which I have elected to speak to you. Let me conclude with a word of warning on the danger of over-specialization. The ultra-specialist is apt to become narrow, to confine himself so closely to his own groove that he forgets to notice what is occurring in the parallel and intercrossing grooves of others. But those who devote themselves to the chemical side of physiology run but little danger of this evil. The subject cannot be studied apart from other branches of physiology, so closely are both branches and roots intertwined. As an illustration of this, may I be permitted to speak of some of my own work? During the past few years the energies of my laboratory have been devoted to investigations on the chemical side of nervous activity, and I have had the advantage of co-operating to this end with a number of investigators, of whom I may particularly mention Dr. Mott and Dr. T. G. Brodie. But we soon found that any narrow investigation of the chemical properties of nervous matter and the changes this undergoes during life and after death was impossible. Our work extended in a pathological direction so as to investigate the matter in the brains of those suffering from nervous disease; it extended in a histological direction so as to determine the chemical meaning of various staining reactions presented by normal and abnormal structures in the brain and spinal cord; it extended in an experimental direction in the elucidation of the phenomena of fatigue, and to ascertain whether there was any difference in medullated and non-medullated nerve fibers in this respect; it extended into what one may call a pharmacological direction in the investigation of the action of the poisonous products of the breakdown of nervous tissues. I think I have said enough to show you how intimate are the connections of the chemical with the other aspects of physiology, and although I have given you but one instance, that which is freshest to my mind, the same could be said for almost any other well-planned piece of research work of a biochemical nature.

We have now before us the real work of the Section, the reading, hearing and seeing the researches which will be brought forward by members of the Association, and I must, in thanking you for your attention, apologize for the length of time I have kept you from these more important matters.

THE PRESENT STATE OF THE ART OF ELECTRO-CULTURE.†

By EMILE GUARINI.

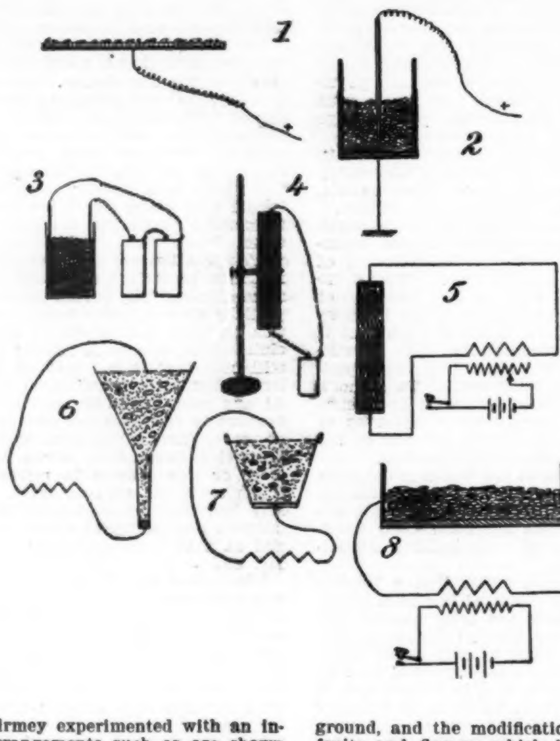
IN order to collect all the known data upon the application of electricity to the cultivation of plants and flowers, La Società Agraria de Lombardia has hit upon the happy idea of opening this interesting subject to competitive discussion.

Electro-culture, as we understand it, is both a science and an art. In this article, we shall treat it from the viewpoint of a practicable art, and, as such, it is divisible into two main divisions: (1) the electrizing of grains or seeds, and (2) electro-culture properly speaking, this latter being again subject to divisions known as (a) electro-culture by indirect influence, or by the utilization of the effects produced by the rays of the electric arc light; and (b) electro-culture by direct influence, or by the utilization of the effects upon the roots or leaves of plants of electric currents passing through the soil or through the air.

Several methods of electrizing the seeds have been attempted. We shall describe a few of them below, with the aid of suitable illustrations. The simplest form, and the one naturally tried first, was the placing of the seeds upon a sheet of glass connected with a machine for producing static electricity; this we show in Fig. 1. The next step was inclosing them within a Leyden jar, connected with a similar charging machine, as shown in Fig. 2. Abandoning the static discharge, the experimenters took up the ordinary battery for their source of current and used a vase or receptacle of any sort whatever for their seeds, provided only that it afforded convenient means of placing, on opposite sides of the seeds, electrodes, which they connected with a cell. This arrangement we indicate in Fig. 3. A modification of this idea, exhibiting progress, is shown in Fig. 4, in which a glass tube serves to contain the seeds, the tube being capped at top and bottom with copper covers which are connected to the source of current.

To insure freer passage of the current about and through the seeds—better conductivity, in fact—they should be well wetted. By this means, also, may be avoided the spoiling of the germ by the heat generated by the resistance to the passage of the current offered by the seeds. In all, this process requires several days, the flow of the current being applied intermittently, or at several distinct periods during that time. Seeds twenty years old have in this manner been made to germinate.

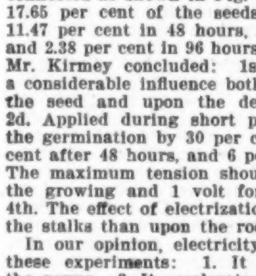
Spechnlev, a Russian botanist, maintained that an induced electric current applied to seeds caused accelerated germination but that, with the application of a direct current to them, the yield was more abundant. He held that the germination of peas was advanced 1½ days; beans, 3 days; and rye, 3 days; while the seeds of the sunflower were induced to sprout 6½ days earlier than ordinarily. In 1894 Paulins declared that dry beans, whether electrized or not, germinated the same day; dampened beans, non-electrized, germinated two days earlier; dampened beans subjected to the electric current for two days germinated somewhat later than the preceding ones, but if the current was permitted to flow through them for 3 days, they germinated much in advance of any of the others.

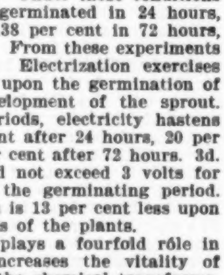


In 1897 Mr. Asa S. Kirmey experimented with an induced current with arrangements such as are shown in the diagram, Fig. 5, which permitted him to vary the tension of his secondary current by varying the number of turns on the primary winding of the induction coil. The result of his experiment was that 32.40 per cent of the seeds germinated in 24 hours, 21.05 per cent in 48 hours, and 6.33 per cent in 72 hours.

Taking one step nearer to nature, he afterward tried electrizing his seeds in the earth by planting them in a funnel filled with soil (Fig. 6); and again, by putting them in an ordinary flower pot (Fig. 7); or a trough or box having its opposite ends of metal and connected as shown in Fig. 8. Under these conditions 17.65 per cent of the seeds germinated in 24 hours, 11.47 per cent in 48 hours, 2.38 per cent in 72 hours, and 2.38 per cent in 96 hours. From these experiments Mr. Kirmey concluded: 1st. Electrization exercises a considerable influence both upon the germination of the seed and upon the development of the sprout. 2d. Applied during short periods, electricity hastens the germination by 30 per cent after 24 hours, 20 per cent after 48 hours, and 6 per cent after 72 hours. 3d. The maximum tension should not exceed 3 volts for the growing and 1 volt for the germinating period. 4th. The effect of electrization is 13 per cent less upon the stalks than upon the roots of the plants.

In our opinion, electricity plays a fourfold rôle in these experiments: 1. It increases the vitality of the germs. 2. It accelerates the chemical transformation of the albuminoids and alimentary reserves incased in the cotyledons, into substances assimilable by the tender sprouts. 3. It decomposes the water of the tissues or of the dampening medium, the oxygen produced thereby actuating the respiration of the embryo plant. In the case of induced currents, electrolysis will be produced by an effect analogous to that of the Wodon electrolytic valve; to that of the Cooper





Hewitt converter; or to that which is seen in the extra current sent through a circuit of great resistance (that having the highest e. m. f. alone passes). 4. It disengages heat advantageous to the germ.

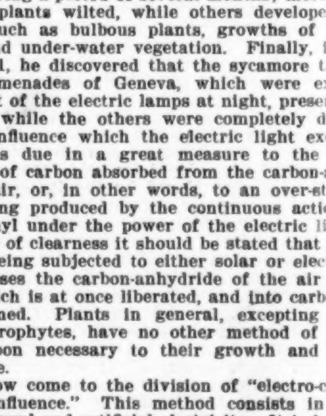
Whatever there may be in it, the results are certainly most remarkable. These are increased in the germinative power, advanced germination, intense development, augmentation of the yield. Unhappily the methods are not yet practicable; otherwise they might render most valuable services in considerably increasing the products of the fields, especially if they were combined with electro-culture.

The first observations upon the influence of the electric light upon vegetation are due to Hervé-Mangon, who, in 1861, proved that the voltaic arc contributed to the formation of chlorophyl. In 1869 Prellieux proved that the function of chlorophyl was accomplished under the electric light. Further experiments and deeper study into the effects of the light upon plant life led C. Siemens, in 1880, to interpose a pane of glass between the light and the plant in order to intercept the ultra-violet rays and thus eliminate their noxious influence.

Fig. 9 gives an idea of how this was done. Again, in 1890-1891, Prof. L. Bailey, of Cornell University, remarked the early fructification and great development of those portions of the plant living above ground, and the modifications in the color of certain fruits and flowers which had been subjected to the mysterious influences of the voltaic arc; and, in 1892, Mr. G. Bonnier proved that the electric light produced a profound modification in the vegetable tissues, especially if they had been subjected to the influence of the light during a period of several months; moreover, that certain plants wilted, while others developed exuberantly, such as bulbous plants, growths of the grass kind, and under-water vegetation. Finally, in December, 1901, he discovered that the sycamore trees upon the promenades of Geneva, which were exposed to the light of the electric lamps at night, preserved their foliage, while the others were completely denuded.

The influence which the electric light exerts upon plants is due in a great measure to the excessive amount of carbon absorbed from the carbon-anhydride of the air, or, in other words, to an over-stimulation or feeding produced by the continuous action of the chlorophyl under the power of the electric light. For the sake of clearness it should be stated that the chlorophyl, being subjected to either solar or electric light, decomposes the carbon-anhydride of the air into oxygen, which is at once liberated, and into carbon, which is retained. Plants in general, excepting parasites and saprophytes, have no other method of obtaining the carbon necessary to their growth and healthful existence.

We now come to the division of "electro-culture by direct influence." This method consists in utilizing both natural and artificial electricity. It is based upon



the observation, made upon the island of Spitzbergen, lying under the 80th parallel, far to the north of Norway and Sweden, and in Finnish Lapland, that the harvests there, periodically, and in spite of the most rudimentary means for cultivation, acquire a development entirely unknown in countries situated more to the south; and that this development coincides with the variations of the solar spots and the aurora borealis.

The auroras, or, better said, the electric currents of the atmosphere which cause them, exercise a marked and powerfully stimulating effect upon the growing vegetation.

Grandeau and Leclercq have proved this by showing that a plant, surrounded by a wire cage as shown in Fig. 10, which will impede or entirely cut off the action of atmospheric electricity, will wilt and die

* There may be a slight reaction with the blood of allied animals; for instance, with monkey's blood in the case of man.

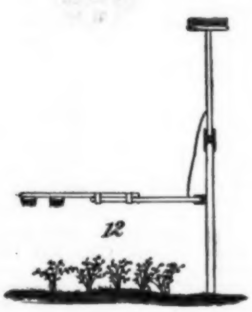
† Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

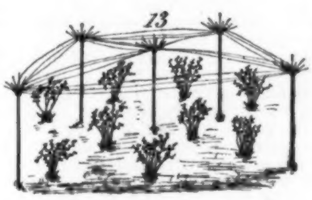
The difference in the production of vegetables treated to electro-culture is from 50 per cent to 70 per cent in favor of the treatment, while the effects upon grains increase the yield from 50 to 60 per cent.

Selim Lemstroem, a physician of the University of Helsingfors, has also demonstrated the efficacy of the electric current, by, as is shown in Fig. 11, disposing a series of pots containing flowers of the same kind in three separate compartments, in one of which all the pots are connected to the negative wire, in the second, to the corresponding positive wire, and in the third are not put in circuit. With all the external conditions the same, the flowers in the electrized compartments, both positive and negative, produced an excess in yield.

As the electricity of the air is to be had without cost, effort has been made to utilize it in this cause. The first apparatus designed for this purpose was invented by the Abbé Bertholon, and he called it the electro-vegeto-meter. It is shown in Fig. 12. The electricity was gathered from the air by a metallic brush or broom, elevated at some distance above the ground upon a mast, and conducted through a wire down and along a horizontal bar attached to the mast, carrying upon its outer end metallic brushes similar to the collector, adapted to be placed over the growing plants; the idea being to deposit the electricity collected by the broom upon the flowers beneath. The results of the experiment were mediocre. Spechniev invented an apparatus shown in Fig. 13, which collected the atmospheric electricity upon gold-tipped copper points carried upon the tops of poles placed in the field and connected by wires. This arrangement proved to be effective, for the increase in production was for rye, 28 per cent; for wheat, 56 per cent; for oats, 62 per cent; for barley, 55 per cent; for peas, 25 per cent; for potatoes, 11 per cent; and 34 per cent for flax. Lagrange, of the military school at Brussels, erected miniature lightning rods, set 15 centimeters in the ground, among the plants, as shown in Fig. 14. We shall return later on to the results of his novel experiment.

As shown in Fig. 15, the geomagnetist Paulins took a marked step in advance of his predecessors. He essayed to supply the unseen as well as the seen organs of the plants with this life and vigor-giving excitement. Upon a wooden mast he erected therefore a metallic top-mast that carried at its head a crown of points projecting in every direction. From this top-mast he led off into the ground, by means of wires, the electric energy gathered upon the antennæ, accomplishing this the more completely by planting his wires below the surface and running them in and out among the plants, thus literally ramifying the soil with them.

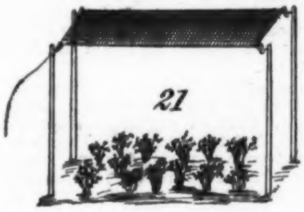


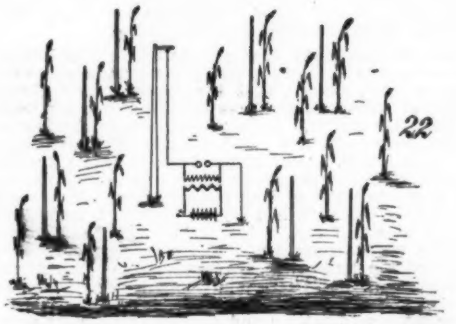


At Merlieu, the apparatus caused an increased yield of 39 kilogrammes of potatoes upon 32 square meters of land; in Norway the experiment yielded an excess of 11.25 per cent in crop and 3 per cent of starch; at Vals, it caused an increased production of 4.7 kilogrammes of spinach upon a surface of 5.4 square meters, and 2.8 kilogrammes from only 2 square meters of land; an excess of beets was raised at Orchies equaling 9 per cent; while at Clifton and at Ecotay the installation of this apparatus permitted grapes and figs to grow to maturity. Evidently taking his cue from M. Paulins, Mr. M. J. O. Markewitsch-Jodko constructed an apparatus, shown in Fig. 16, which was very similar to the preceding, with the differences that the posts or masts were slighter and in one piece, with the crowns alone insulated, and having wires from them running into the ground and terminating in plates of zinc, so as to form a better "ground." Placed so that from 10 to 15 of these masts would cover a hectare (something over two acres), the total expense would not surpass 40 francs. Results prove the efficacy of the installation, for the yield in fruit at one time rose from 312 to 525 kilogrammes. Of the other methods, a few make use of dynamic electricity produced by planting copper and zinc plates in the ground and connecting them above the surface with wires. This method is shown in Fig. 17. Spechniev obtained some more or less satisfactory results with this system. Lagrange attempted this also, but took the precaution to insulate his wires. His arrangement is shown in Fig. 18. With all other conditions the same, the cultivation of a field of potatoes under the influence of atmospheric electricity yielded 163. A field excited by dynamic electricity yielded 60; while a field left to itself, or devoid of either method of excitement, produced 80. It was found that the dynamic excitement was always productive of an abundance of leaves and early and highly developed flowers, proving itself useful for legumes, or leafy plants.

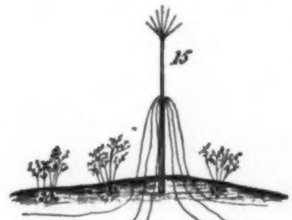
Markewitsch-Jodko was not very successful with experiments in which he allowed the naked wires to lie upon the ground, as shown in Fig. 19.

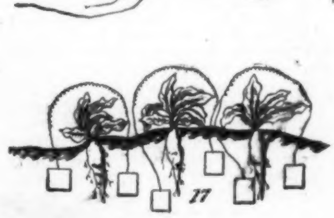
Not content with his experiments upon the pots of flowers, Prof. Selim Lemstroem decided to introduce static electricity in his future trials, and for this purpose invented a machine which he operated in combination with a network of wires carefully insulated from the ground, and spread out above the plants in an open field, as shown in Fig. 20. The cross wires are run about 1 meter apart, each wire being supplied with 50 small metallic points or rods situated at intervals of 50 centimeters and projecting downward into the air. The electric generator is run from 7 to 8 hours a day, ordinarily between the hours of 7 and 11 A. M. and 4 and 8 P. M. In the more recent experiments, the network was composed first of a plain galvanized wire 1.5 millimeters in diameter running around the four sides of the field and supported on ebonite insulators on the four corner posts, as shown in Fig. 21. From two opposite sides of the parallelogram thus formed, and at a uniform distance of 1.25 meters apart, were stretched other and smaller wires .5 millimeter in diameter, in order to complete the screen.

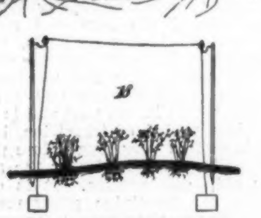


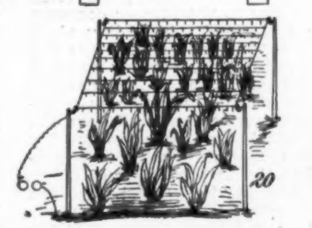


After subjecting this small area, in 1898, to the electrical treatment for 164 hours, the ground yielded an excess of 39 per cent. This high percentage could not be maintained throughout the list of products because the electrical energy affected the growth of the various plants in a different degree, so that while the excess for carrots was only 8.7 per cent, for beets it reached 11.8 per cent, with beans only a trifle behind, showing an increase of 11.1 per cent. During the following year, when the experiments were made upon a more extensive scale, the excess over ordinary production advanced by leaps and bounds. Oats showed a percentage of 28.7, barley 23, carrots 37.5, and the yield of potatoes was exactly half as much again.









The experience gained in this year of work disclosed weaknesses in the system and suggested improvements, so that at the close of the season following (1900) the records showed substantial increase in gain all along the line; barley came off with an excess of 26.4 per cent, peas 55.7 per cent, potatoes 17 per cent, strawberries 88.7 per cent, sugar beets 42.2 per cent, carrots 92.7 per cent, with beans ending the list at 33.3 per cent.

In 1899 the coefficient of excess for grain of prime quality was 26 per cent, while it was 9 per cent for wheat and 32.1 per cent for rye.

From these experiments Prof. Lemstroem concluded: 1st. The mean increase in production to be about 40 per cent. 2d. The increase is in direct ratio with the fertility of the soil. 3d. Electric treatment is harmful during the heated terms. 4th. Certain plants give out an excess only when they are copiously irrigated, failing which the electric treatment is baneful.

In our opinion, use might also be made of an oscillator with antennæ, disposed at convenient positions about the field. These could be constructed much upon the plan of those used in wireless telegraphy, and similarly to the one shown in Fig. 22. The current would be gathered by induction by means of the galvanized iron poles planted in the earth and by the growing plants themselves playing the part of miniature antennæ. In this manner an electrizing of both the soil and the plants would be effected.

Although evident, the influence of electricity has not yet been sufficiently elucidated as far as concerns its action, which is at all events complex. Electricity causes electrolysis of the salts contained in the soil, decomposing them and recombining them into other salts more easily assimilable by the plants; it brings into greater activity the vitality of the organism, and facilitates the exchange of gases between the leaves and the atmosphere; it gives new vigor to the respiration, aids the fixation of the carbon, the transpiration, the nutrition, and the multiplication of cells; it assists the ascension of the sap by stimulating osmosis and by forcing the sap to mount to the capillary vessels.

Prof. Lemstroem has given practical evidence of the particular power of electricity, and, by consulting Fig. 23, one can see the phenomenon lucidly demonstrated. Here the open end of a capillary tube has been passed beneath the water contained in any convenient vessel, and this water connected by wire with the earth. A finely pointed metal rod forming an electrode is inserted in the upper, or dry end, of the tube, and connected by wire with the negative pole of an electric influence machine. Whenever the machine is set in motion, small drops of water will appear in the upper part of the tube. This identical phenomenon is repeated in the capillary vessels of the plant when it is subjected to the influence of a flow of electricity. It is the negative current atom passing from the soil toward the point of the wire, that causes this action. The positive current brings to the plant the divers elements of the atmosphere and introduces them into the tissues, there to be assimilated. It seems, then, that the employment of the alternating current might also be advantageous in this work. Viewed from this standpoint, the wireless system with the Hertzian waves appears to us to be particularly well adapted to the service.

Very probably the rôle played by electricity in the economy of plant life is much more important than we have been able to indicate up to the present time. However, with the advent of new methods of investigation and other forms of application, we shall again return to the subject.

The few thoughts above expressed and examples set forth serve to show that electro-culture is excellent in principle and full of promise for the future; the results already obtained prove it. It remains only to discover practicable and economical means of putting it into operation. That day will dawn, and electricity, widely applied, will bring to the suffering agriculturist the same, perhaps greater, benefits it has so bountifully conferred upon other industries.

Let us hope, then, that the day is near, for the prosperity of the farmer is reflected in the other industries which are more or less tributary to agriculture.

ENGINEERING NOTES.

The second steel pen works to be opened in Russia will start working soon in the outskirts of St. Petersburg. Female labor alone is to be employed in the new works.

The cross-Channel turbine steamer "Queen" is said to have behaved splendidly during recent southwesterly gales. In a gale of wind she crossed from Dover to Calais in 59 minutes and arrived with a dry upper deck. The return passage was made, after taking in more water ballast, in 69 minutes.

A train arrived at Beaumont, Tex., on Sunday, July 26, 1,040 days late. It was the Gulf & Interstate passenger train which left Galveston on September 8, 1900. Caught by the terrible Gulf storm which destroyed Galveston, the train since that time has been standing on a section of track, which has once more been connected with Beaumont.

During July Scotch shipbuilders launched 17 vessels, of about 17,315 tons gross, as compared with 29 vessels, 29,885 tons gross, in June, and 19 vessels, of 32,022 tons gross, in July last year. In the seven months Scotch builders have launched 156 vessels, aggregating 292,326 tons gross, as compared with 176 vessels, of 331,768 tons gross, in the corresponding period of last year.

From reports published in Engineering it would seem that British locomotive builders more than held their own in the Japanese market last year. Out of 63 locomotives ordered 45 were supplied from Great Britain, and 18 by American builders. Three or four engines were built at the government works at Kobe, in the Sanyo Railway Company's works, and at the Osaka locomotive works.

That the United States still continues to number bridges among its articles of commerce is shown by the fact that a good many finished trestles were sent out to Formosa from this country during the last year. There is, however, a very marked falling off in the total value when compared with 1901. The heavy duty, 20 per cent, imposed on the finished work prevents its competing with the unfinished material, which pays a duty of less than 5 per cent *ad valorem*. The result is that there is a growing tendency to import the unfinished material—a great quantity of which comes from the United Kingdom—and make it up in Japan.

English shipbuilders in July launched 26 vessels, of about 49,132 tons gross, against 26 vessels, of 52,208 tons gross, in June, and 35 vessels of 78,617 tons gross, in July last year. For the seven months English builders have launched 170 vessels, of 354,714 tons gross, as compared with 160 vessels, of 432,646 tons gross, in the corresponding period of last year. There have been launched in the United Kingdom during the past seven months 334 vessels, totaling about 642,790 tons gross, as compared with 345 vessels, of 791,792 tons gross, in the first seven months of last year.

During the year ending June 30 last, 1,535 vessels of 456,076 gross tons were built in the United States, compared with 1,657 vessels of 473,981 gross tons for the previous 12 months. Returns of vessels under construction on July 1st last indicate for the new year an output below that of the year just ended. The principal decrease for the past year has been in steel steamers built on the great lakes, which numbered 41 of 131,660 tons, compared with 52 of 161,797 tons for the fiscal year 1901-2. Nearly two-thirds of the year's output consists of 92 vessels of over 1,000 tons each, aggregating 295,548 gross tons. Of these the great lakes yards built 37 steel steamers aggregating 130,283 gross tons. On the seaboard 18 ocean steel steamers of 101,471 gross tons were built.

Canada is ambitiously inclined toward having, even if she has to pay for it, a shipbuilding industry. The fine vessels which used to be turned out of the St. Lawrence yards of the sea-bound provinces were in their days ships of which any country might well be proud. Liverpool has harbored hundreds of these craft, and the "bluenoses" were ever welcome to the port for they were splendid, well-kept ships, and their custom was eagerly sought after by the tradesmen of Liverpool, and was well worth having. Owing to the displacement of wood for the better and more durable steel in ship construction, the ring of the live-oak mallet has practically ceased in the once busy yards of the Nova Scotia mainland and Newfoundland. Fewer ships bearing the Canadian legend on their sterns are to be seen every year, and this will continue until eventually the class of ship now so decorated will be a thing of the past. But before that time arrives Canada will have her steel ships plowing the main and supplanting those now rapidly dying out. With the development of the iron and steel industry in the Dominion, the laying of keels, the bending of frames, and the riveting of ship plates will follow as a natural consequence, for the maritime provinces will continue to breed seamen and shipbuilders just as has been the case in the past and is at the present time. This is a period of transition, but it does not appear that it will be very long before the sounds of the shipyard will again be stirring the air in centers suitable for ship construction. It is expected almost daily that the Dominion government will offer an increased bonus to the firm or company which will establish a competent shipbuilding plant in the country. The amount already offered has not had the effect of inducing builders to lay down a plant, but the movement now afoot to increase the amount of offer to a sum which will enable an enterprising concern to see its way to start will have the desired effect. Nova Scotia is keen on advancing the scheme, and the decision now rests with a government which certainly has the best interests of industrial Canada at heart, and which cannot be charged with niggardliness in forwarding the Dominion's welfare. The Dominion Iron and Steel Company is undoubtedly in the best position to take the matter up, and negotiations will be commenced with the company immediately it is decided to offer sufficient inducement. Nova Scotia would benefit immensely by the establishment of a large shipyard there, hence the evident anxiety of the local government to secure the assistance of the Ottawa government.—Liverpool Journal of Commerce.

ELECTRICAL NOTES.

M. Maneuvrier, assistant director of the Reswich Laboratory, has discovered what he claims to be an accurate method of detecting the degree of adulteration of a given quantity of wine.

The principle on which the method is based is the variable conductivity of different liquids, notably wine and water, and the instrument by which the tests are made is the telephone. M. Maneuvrier's ingenious application of the telephone to a special apparatus enables him to determine to what degree the liquid under observation is a conductor.

Experience in Germany and France has shown that gas-driven blowing engines are particularly adapted to blast-furnace work. German engineers state that experience has proved that the quantity of waste gas from the furnaces used for a gas-driven engine is about one-fourth of that required to raise steam in good boilers, to drive a steam blowing engine of the same capacity. The cost of the gas-driven blowing engine, including purifying plant for the gas, is about the same as that of a compound or triple-expansion engine of the best type. With the gas engine, the cost of the boilers will be saved.—Eng. Record.

It is so extremely dangerous to take steam locomotives, or even electric motors driven by a trolley wire, into cotton factories, that the Massachusetts Cotton Mills, at Lowell, Mass., have decided to use a storage battery locomotive. Cars were formerly hauled by three horses within a short distance of the entrance to the building. After unhitching the horses, the car was permitted to run along by its own momentum until it reached the desired place. Its extreme length is 21 feet, 4 inches, and height 12 feet, 1 inch. The wheel base is 7 feet, 6 inches in length, and on the level it attains a speed of 2 to 4 miles per hour. Both ends of the locomotive are employed for the accommodation of the battery, and the axles are driven by chain gearing. By varying the connections of the two specially-wound motors and the battery efficient speed control is effected. Two levers control all the motions of the locomotive, and the controller possesses no features of special interest.

M. Key has made some observations of the cathode and anode falls of potential near the surface of electrodes consisting of potassium or sodium. When the gas is nitrogen, the nitrides NH_3 and NNa_3 are produced and when it is hydrogen there is a probable formation of KH and NaH. The absorption of nitrogen takes place chiefly at the cathode. The formation of the compounds mentioned provides an excellent means of separating the rarer gases, such as helium and argon, from the commoner ones. It is best to employ a cathode made of sodium-potassium alloy for the purpose. In helium, the anode drop of such an alloy is high, and thus confirms Skinner's supposition, that metals of low cathode drop have a high anode drop. In helium, also, the alkali metals show the smallest known cathode drops, being thirty volts for sodium, sixty-nine for potassium and 78.5 for the alloy. This may have some connection with the photoelectric power of the same metals. The series of metals arranged according to their cathode fall is the same in every gas, and is identical with the Volta series, or the series of densities, or the series of affinities for oxygen.—Electrical Review.

The diaphragm question remains one of the most important problems for the electro-chemist. Clay, which, on the whole, gives the most widely applicable diaphragms, cannot easily be supplied in large plates; clay diaphragms are also fragile and expensive, and introduce a high electric resistance. Alkaline electrolytes attack the clay, moreover. In acid electrolytes, membranes, much improved of late, are used with fairly satisfactory results. For alkaline lyes, asbestos paper seemed to afford an excellent diaphragm material. The compressed asbestos pulp gradually softens again, however, even in liquids which do not attack it chemically, and the diaphragms do not last so long as was expected. Addition of cements and impregnation with chemicals have been tried; but these ingredients clog the capillary passages to which the asbestos diaphragms owe their low electric resistance, and thus treated, asbestos is not chemically so indestructible as the natural mineral. Artificial silica diaphragms have been prepared by Le Blanc and Alic; they consist of about 75 per cent of silica and 23 of clay, the rest being made up of 2 per cent of alkali, added in order to decrease the electric resistance of this material. But these products and other stones of similar composition are also fragile, and cannot be manufactured in large plates, nor at low prices. The magnesite diaphragms seem so far to have been applied more in primary cells than in electrolytic cells. The chemical works of J. Bernfeld & Co., of Leipzig-Plagwitz, now claim to have rendered asbestos paper much more durable, without any additions, simply by a careful calcination in the furnace at a moderate temperature. In appearance the improved asbestos paper does not differ from the ordinary product. It can be cut with the knife and scissors, and is sufficiently elastic to permit of being used in ordinary electrode frames of electrolytic filter presses without requiring any special mounting. The electric resistance of these diaphragms is very low. A plate 2 millimeters in thickness and 1 square meter surface has a resistance of only 0.00018 ohm in a 25 per cent solution of sodium chloride. This low resistance does not signify high porosity. That would be undesirable, since the diaphragm is to keep the anode and cathode lyes apart. Le Blanc pointed out two years ago that electric resistance and porosity are not directly proportional to one another in a diaphragm. The diaphragm conducts the current because its capillary passages are filled with electrolyte; that conductivity increases proportionately to the cross-section of the capillaries, according to Ohm's law. The diffusion of liquid through the diaphragm takes place through the same capillaries; but it increases with the square of the cross-section. Large pores would, of course, render a diaphragm unsuitable. The Bernfeld asbestos diaphragms can be kept for any length of time in hot neutral and alkaline solutions, and will, it is stated, prove fairly stable in acid electrolytes.—Engineering.

TRADE NOTES AND RECIPES.

Liquid Grease-Spot Remover.—An excellent liquid spot remover, says the Wurtembergische Gewerbeblatt, is made as follows: Dissolve any good domestic soap in ammonia water by agitation, and if necessary thin down with ammonia water to about the consistency of syrup. To use, smear some of the liquid over the spot and rinse out with warm water.

Colored Sand.—The "Techno-Chemical Receipt Book" is authority for this information: Sift fine white sand from the coarser particles and color it as follows:

1. Blue.—Boil 106 parts of sand and four of Berlin blue with a small quantity of water, stirring constantly, and dry as soon as the sand is thoroughly colored.
2. Rose-colored sand is obtained by mixing 100 parts of white sand with four of vermilion.
3. Dark Brown Sand.—Boil white sand in a decoction of Brazil wood and dry it over a fire.
4. Black Sand.—Heat very fine quartz sand, previously freed from dust by sifting, and add to every ¼ pound of it six to eight spoonfuls of fat. Continue the heating as long as smoke or a flame is observed on stirring. The sand is finally washed and dried. This black sand will not rub off.

Vulcanization.—Besides the Goodyear, Mason and other patented processes, the process now usually followed in vulcanizing rubber stamps and similar small objects of rubber, is as follows:

Sulphur chloride is dissolved in carbon disulphide in various proportions, according to the degree of hardness the vulcanized object is to receive; the rubber cast is plunged in the solution and left there from 60 to 70 seconds. On removing, it is placed in a box or space warmed to 80 deg. F., and left long enough for the carbon disulphide to evaporate, or about 90 to 100 seconds. It is then washed in a weakly alkaline bath of water and dried.

Another method (that recommended by Gerard) depends upon letting the rubber lie in a solution of potassium *ter* or *penta* sulphide, of 25 deg. B. heated to about 280 deg. F. for 3 hours.—Nat. Drug.

Reliable Welding Powder.—To weld cast steel with cast steel or with iron, a welding powder has to be made use of, if a secure seam is desired, since cast steel cannot stand sparkling heat. An excellent welding powder is produced as follows: In an unglazed iron vessel or crucible fuse borax in an annealing furnace until the liquid appears entirely dark green. Test the molten mass by immersing a wire or piece of iron, to which a sample will cling. First the molten mass is pale yellow, but it gradually turns darker. As soon as the sample taken with the iron rod, which immediately cools into a hard mass, acquires a dark green or black color, the moment has arrived to remove the vessel from the fire in order to pour the contents into another cold, but dry, receptacle. After complete cooling the glass-like dark mass is crushed in a mortar into a coarse powder. The powder is pale greenish yellow, and is now mixed with an equal volume of steel filings. In storing the welding powder it must occupy a dry place to prevent the filings from rusting.—Der Metallarbeiter.

A new insect destroyer is published in the Druggist's Circular and Chemical Gazette, which seems well worth trying. To half a gallon of kerosene oil add a quart of spirit of turpentine and an ounce of oil of pennyroyal. This mixture is far less dangerous than benzin, being not near as volatile. As an efficient destroyer of insects it is said to have no superior. The pennyroyal as well as the turpentine are not only poisonous but exceedingly distasteful to insects of all kinds. The kerosene while less quickly fatal to bugs than benzin is cheaper and safer and when combined with the other ingredients becomes as efficient.

Where the wall paper and wood work of a room have become invaded, the usual remedy is burning sulphur. To be efficient the room must have every door, window, crevice, and crack closed. The floor should be wet in advance so as to moisten the air. A rubber tube should lead from the burning sulphur to a key hole or auger hole and through it, and by aid of a pair of bellows air should be blown to facilitate the combustion of the sulphur.

Frosting Glass.—Dip a piece of flat marble into glass cutter's sharp sand, moistened with water; rub over the glass, dipping frequently in sand and water. If the frosting is required very fine, finish off with emery and water. As a temporary frosting for windows, mix together a strong, hot solution of Epsom salt and a clear solution of gum arabic; apply warm. Or use a strong solution of sodium sulphate, warm, and when cool, wash with gum water. Or daub the glass with a lump of glazier's putty, carefully and uniformly, until the surface is equally covered. This is an excellent imitation of ground glass, and is not disturbed by rain or damp.

Imitation Ground Glass.

Sandarac	2½	ounces
Mastic	½	ounce.
Ether	24	ounces
Benzine	16 to 18	ounces

This mixture is to be painted on the glass.

"Hoarfrost" glass, so called from the pattern made upon it, which resembles the feathery forms traced by frost on the inside of the windows in cold weather, is said to be made as follows:

The surface is first ground either by sand-blast or the ordinary method, and is then covered with a sort of varnish. On being dried either in the sun or by artificial heat, the varnish contracts strongly, taking with it the particles of glass to which it adheres; and as the contraction takes place along definite lines the pattern removed by the removal of the particles of glass resembles very closely the branching crystals of frostwork. A single coat gives a small, delicate effect, while a thick film, formed by putting on two, three or more coats, contracts so strongly as to produce a large and bold design. By using colored glass, a pattern in half-tint may be made on the colored ground, and after decorating white glass, the back may be silvered or gilded.—Pharm. Era.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Anglo-German Commercial Relations.—The following is from the London Times of July 9, 1903:

"Sir William Ward, British consul-general at Hamburg, in a report on the trade of his district for last year observes that the existing régime under which Great Britain and Germany accord to each other most-favored-nation treatment (Germany, however, excepting Canada) will come to an end in December next. Opinion in the mercantile classes of Hamburg and of the other important German seaports is strongly in favor of maintaining the present relations between Germany and the British dominions and of making a treaty similar to the existing one for a term of at least ten years, and it is hoped at the same time that means may be found for placing the commercial relations of Germany with Canada on a satisfactory footing. The importance of Anglo-German commerce is so great that the result of the negotiations about to be commenced in Germany for new treaties with other countries will be watched with keen interest, as the future commercial relations between the British and German empires will be affected by them. The leading commercial classes of Hamburg have recently expressed the hope that all those duties mentioned in the new German customs tariff for which no minimum rates have been specially provided, and which were increased by the customs committee of the German Parliament beyond the figures originally fixed by the government, will be reduced again under the new treaties, not merely to the previous figures, but to the rates fixed by the conventional tariff. The Hamburg Chamber of Commerce, in its last report, also earnestly recommends that no commercial treaty should be concluded with any country without a clause providing for the most-favored-nation treatment to Germany, so that the latter may be able in future to compete on equal terms with other countries in the markets of the world.

"As regards British trade with Hamburg, the consul-general states that the exports and imports were larger in 1902 than in 1901, and the number and tonnage of British ships entering the port were the largest on record. In a total tonnage of seagoing ships of 8,688,627 tons entering Hamburg in 1902, 3,125,906 were British and 4,617,373 German, and 2,602,000 tons were from the United Kingdom. The figures for the shipping show a decrease in the total tonnage of the carrying trade between Hamburg and non-European countries, more especially the United States, and an increase in that with the United Kingdom. The consul-general fears that sufficient attention has not been given in Great Britain to the effect on trade of the German-Levant tariff of freights for goods sent from inland German towns under through bill of lading to Levantine ports. This tariff has assisted in rapidly developing German trade with the Levant and the Black Sea to a greater degree than even the East Africa tariff has built up the trade between Germany and that region. Last year (1902) the total imports of Hamburg by sea amounted to £112,543,622 ($547,693,936) and the exports to £93,094,325 ($453,435,326). The imports from the United Kingdom were £19,752,797 ($96,126,987), or 11½ per cent of the whole, and the exports £22,223,900 ($108,152,499), or 20 1-3 per cent of the whole. Hamburg's imports from British North America last year only reached £382,386 ($1,860,930) and the exports £875,141 ($4,258,873). More than half the entire trade of Great Britain and Germany passes through Hamburg. As to trade with Canada, contrary to the experience of 1901 and previous years, the import trade of Hamburg from Canada has increased and the exports have diminished. Probably this is due to temporary causes, for since 1898—the year in which Canadian imports ceased to get the most-favored-nation treatment in consequence of Canadian preferential treatment of the trade of the mother country—Canadian imports to Hamburg have been declining, while the exports from Hamburg have increased in volume and value, as appears from the following figures:

Year.	Imports.			Exports.		
	Quantity.	Value.		Quantity.	Value.	
	Cwts.*			Cwts.*		
1898	1,987,604	£576,575	$2,805,902	1,258,152	£717,539	$3,491,903
1899	970,102	315,321	1,534,510	1,2 2,618	827,805	4,028,512
1900......	719,910	316,432	1,540,056	1,029,214	662,669	3,224,586
1901......	439,890	257,266	1,251,985	1,655,144	977,646	4,757,714
1902......	625,628	382,396	1,860,930	1,493,262	875,141	4,258,873

* 1 cwt.=112 pounds.

"Hamburg absorbs 70 per cent of the trade of Canada with Germany. The imports from Canada chiefly affected are rye, wheat, maize, barley, oats, butter, lard, and salted and smoked meat; while buckwheat, peas, phosphorus, asbestos, train oil, clover seed, linseed, wood, wood pulp, cotton waste, and canned goods have remained much the same since 1898. As regards exports from Hamburg to Canada, sugar, chemicals, drugs, nitrate, pig and smelting iron, iron bars and iron manufactures generally, glue, gelatin, glass bottles, porcelain, and toys have increased in the last three years; while rags, peltry, paper, tanning extracts, and textiles have declined."

Trade in the Wuchow, China, Consular District.—In the report on the trade of Wuchow for 1902 by the acting British consul at that port, which appeared in the British Board of Trade Journal of July 16, it is stated that no new lines of piece goods were introduced last year, but a small consignment of German silk-finished velvets and white broadcloth found a ready sale. The same may be said of cheap Japanese cotton cloths, flannels, and crapes. Cotton velvets, flannels, cashmeres, Italian cloth, and crapes, etc., are gradually being substituted for the native silk and cotton stuffs formerly worn, as they offer greater variety of texture and color combined with cheapness. Fashions change in China as elsewhere and a new cloth or color, if it suits the popular taste, is sure to find a ready sale.

Silk and satin ribbons of foreign make are coming into use for ladies' dress trimmings; they should be of narrow width, and, if possible, embroidered with flowers or some native design. There is a growing demand for cheap foreign underclothing among both sexes.

The import of foreign medicines into Wuchow grows slowly, but steadily. The best-known medicines at present are quinine in powder and tabloids, cod-liver oil and its emulsion, iodine and iodide of potassium, sulphate of zinc (for eye lotions), etc. This should be a large field for foreign materia medica, more especially in the form of patent medicines.

There is a general tendency among the well-to-do Chinese in Wuchow to substitute articles of foreign manufacture for native whenever the price of the former permits. In this way, cigarettes and cigars, condensed milk, coffee and biscuits, razors, scissors, soaps and perfumes, enameled-ware teapots, basins, etc., are coming into general use.

Attention is also called to the fact that the Chinese are beginning to use soap for shaving and it is suggested that there might be a sale for a cheap scented shaving soap, preferably colored and packed in tins.

A Chinaman, and more particularly a Chinawoman, always looks to the box, case, tin, or bottle, as the case may be, when purchasing foreign goods. The covering, if it may be useful in the household, will always recommend an article to the bargain-loving Chinese.

Tobacco should be of mild quality and slightly sweetened to suit the native taste.

There is a large variety of foreign perfumes on sale in the Wuchow shops; they are chiefly of French and German manufacture, selling at 1s. to 1s. 6d. (24 to 36 cents) per bottle. Here, again, the article is recommended by the shape and quality of the bottle.

The import of rubber boots and shoes increased last year by 2,000 pairs. The current retail prices were: Boots, 3s. 6d. (85 cents) per pair; shoes, 3s. (73 cents) per pair. These boots and shoes are of native pattern, but they would be more acceptable if the soles were made at least one-fourth of an inch thick, similar to the ordinary Chinese shoe. The native does not wear these articles as goloshes over his own shoes, but instead of them; hence a light india-rubber sole does not afford sufficient protection to the foot in a country where there are no roads and where street pavements consist principally of broken bricks and stone.

Russia's Paper-making Industries.—The Austrian consul-general, according to the Nachrichten für Handel und Industrie of July 11, 1903, reports as follows in regard to paper making in Russia:

"Still, the situation is far from favorable. The cause is to be sought not only in overproduction and the universal industrial and agrarian crisis, but in particular conditions that in the very near future will work still further evil. Among the particular conditions or special reasons for the evils that now afflict the paper makers, the low state of the intellectual development of the people comes first. Besides, the direct purchasers of paper have developed great skill in holding back their buying for speculating purposes. This results in reduced prices among the competing concerns. Again, the competition is still further intensified by the absence of any agreement as to production among the manufacturers. The chief difficulty is in the cellulose industry. A German cellulose company established works at Pernau (Livland), which soon set up a very successful series of competitive efforts against Russian manufacturers. Several cellulose makers, in order to more successfully meet this competition, established paper-making plants of their own. This reacted disastrously on the paper-making concerns already established. The disastrous results are seen in the declared dividends of 1902, which averaged only 2.78 per cent on the capital invested. If from this the losses of the makers who labored under losses are taken, the average earnings are reduced to 1.21 per cent. It is thought that the results of 1904 will be even lower. This state of affairs has led to poor and delayed payments. Many debtors demand a year and even eighteen months' time in which to pay, and these are often conceded. Even to all this, one has to add deductions from bills and uncovered or insecured credits. The consul-general warns parties exporting paper to Russia to pay attention to the fact that it is hard to find out the standing of Russian business concerns. The Finnish paper mills are successfully competing with Russia's factories, although they have to pay a small import duty. They have a better class of help, cheaper and better wood in unlimited quantity, and a water power that costs nearly nothing. Still Finland suffers from overproduction since it lost its power to export to England, being unable to compete with the Scandinavian countries. The future, therefore, for Russia's paper making is dark indeed."

International Trade Situation.—The Russian-German Messenger, in its issue of July 1, 1903, urges, in its leading editorial, the importance of nations getting the opinions of distinguished disinterested experts in all their efforts to establish reciprocity in their trade relations. The Italian Minister of Finance, Luzzatti, says the Messenger, is such an expert. In an essay from his pen, published in a leading Viennese journal, he deals with the dangers that are likely to arise from a too careless consideration of the mutual interests and relations involved in the formation of treaties of reciprocity, particularly those affecting trade. Among other things, he says it is not good policy to pull down an old house till a new one has been built; in other words, it is far from wise to break from an old trade treaty before the new one is in force. In this way nations will be able to avoid the tariff wars that were never known to benefit anybody, least of all those engaged therein. The spirit of equity, he says, counts for much in international affairs, even when dealing with the weak as well as with the strong. It carries the farthest and lasts the longest. The word reciprocity, or what the word stands for—mutual benefit—is now an axiom in the commercial-political world. It alone can prevent the awful stupidity of a tariff war. Writing of a possible tariff war between Germany and Russia, M. Luzzatti says:

"Suppose Germany does put a maximum tariff on Russian cereals? Who will be benefited thereby? Hungary, Roumania, Argentina, the United States, and others—not Germany or Russia. If it puts its maximal tariff on all importations of grain, it will have on its hands a universal tariff war, and that for so powerful and envied a state would be the worst thing possible."

Germany must see, continues the Italian statesman, that it will invoke industrial opposition if the Bundesrath does not reduce the tariff rates some points below those established by the Reichstag's minimal. If it does not do this, it will be found wanting in the demands of duty. There is no lack of ways and means to make good the losses to the nation's producers. In France premiums are offered and paid, taxes are reduced, etc. Who, for the sake of a few cents, would wish to plunge Europe or the world into such a war? Industrial peace is worth everything and every effort. Government must see that the absence of trade treaties may mean war.

As in politics, continues the distinguished statesman, so in industrial life, danger and the desire for gain must be kept in the right relations to each other. At present, in Europe, there are signs of tariff war, and yet the chance to win is small and might be secured by a much cheaper process. This is so self-evident that it must appeal to all except one-sided or blinded industrial leaders. It is unwise to let the peace of the world depend upon people who want to try their newly invented explosives, who for the sake of these would let loose the dogs of war. Even if the cereal-raising farmer is injured, it will not be hard to make up to him in some way the amount he loses by the reduced rates. Besides, foreign imports can be aided by means of reduced railroad rates. To find compensation for a devastating tariff war, or for the breaking off of old commercial connections, one will have to look long and far.

New Galvanic Batteries in Germany.—A new German patent relating to galvanic batteries of the class which is composed of a series or plurality of separate dry cells has been issued. The improvements cover the production of a battery which is capable of being kept in store, of being transported in an absolutely dry condition, and of being rendered fit for use at a moment's notice by the introduction of a suitable liquid or electrolyte into the separate cells constituting the battery. The object aimed at appears to have been secured by certain novel features of construction and combinations of parts.

The dry cells consist each of a zinc or other metallic cylindrical electrode, and of a carbon electrode having a cylindrical or prismatic cross-sectional area placed within the metallic cylinder. The space between the two electrodes is filled up with blotting paper or other suitable material capable of absorbing the electrolyte. A plurality of these cells is arranged within a suitable socket or frame-shaped casing, the cells being separated from each other and the surrounding casing by asphalt or other insulating material. When required for use the covers are removed from the cells and filled up with the blotting paper soaked with any convenient electrolyte, such as ammoniac solution, etc. The covers are then replaced and the battery is ready for use. Insulating rings at the open ends of the cells or zinc cylinders prevent short circuiting of the cells by any overflowing electrolyte.—Oliver J. D. Hughes, Consul-General at Coburg.

Tools and Implements in the Transcaucasus.—The British consul at Batum, in the London Board of Trade Journal, calls attention to a movement among the Transcaucasian people to put better tools, implements, and machines into their shops and on to their farms. The desire to do this is based upon a belief that this is the only way in which the so-called house industries can hold their own in competition with the factories. The government is giving moral and material aid to the movement. Among the articles affected, tools and looms for the preparation and weaving of woolen goods, silks, shoes, furniture, and household effects come first. An effort is also being made to get the Transcaucasians to turn from their primitive ways, tools, and farm implements to those of western peoples.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. The other Reports can be obtained by applying to the Bureau of Trade Relations, Department of Commerce and Labor, Washington, D. C. Since the number of Reports is limited, application for those which are desired should be made immediately.

SELECTED FORMULÆ.

Pyrotechnic Papers.—Substitute for Bengal Fires.—Fuses.—The so-called pyrotechnic papers are sheets of bibulous paper saturated with solutions of various salts, mostly of strontium, potassium, sodium, etc., which when ignited burn, for a longer or shorter time as the case may be, with a very brilliant flame, resembling "Bengal lights." The following are some of the latest, taken from the book of M. Dillon, a French authority on the subject:

Red Fires.

1. Strontium nitrate	20 parts
Potassium chlorate	10 parts
Alcohol	20 parts
Water	100 parts

Mix and make a solution.

2. Strontium nitrate	20 parts
Strontium chlorate	5 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

3. Strontium chlorate	20 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

4. Lithium chloride	10 parts
Potassium chlorate	20 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

Blue Fires.

1. Potassium chlorate	10 parts
Copper chlorate	20 parts
Alcohol	20 parts
Water	100 parts
2. Copper chlorate	100 parts
Copper nitrate	50 parts
Barium chlorate	25 parts
Potassium chlorate	100 parts
Alcohol	500 parts
Water	1,000 parts

Mix, etc.

Green Fires.

1. Barium chlorate	20 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

2. Barium nitrate	10 parts
Potassium chlorate	10 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

3. Barium nitrate	10 parts
Barium chlorate	10 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

Yellow Fires.

1. Sodium oxalate	10 parts
Potassium chlorate	10 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

2. Sodium chlorate	20 parts
Potassium oxalate	10 parts
Alcohol	20 parts
Water	100 parts

Mix, etc.

Violet Fires.

1. Strontium chlorate	15 parts
Copper chlorate	15 parts
Potassium chlorate	15 parts
Alcohol	50 parts
Water	100 parts

Mix, etc.

2. Potassium chlorate	20 parts
Strontium chlorate	20 parts
Copper chlorate	10 parts
Alcohol	50 parts
Water	100 parts

Mix, etc.

Lilac Fires.

Potassium chlorate	20 parts
Copper chlorate	10 parts
Strontium chloride	10 parts
Alcohol	50 parts
Water	100 parts

Mix, etc.

The directions for using these solutions are simply to imbibe bibulous papers in them, then carefully dry and roll tightly into rolls of suitable length, accordingly as to the length of time they are to burn.

Fuses.

For fuses or igniting papers, the following is used:

Potassium nitrate	2 parts
Lead acetate	40 parts
Water	100 parts

Mix and dissolve, and in the solution place unsized paper; raise to nearly a boil and keep at this temperature for 20 minutes. If the paper is to be "slow," it may now be taken out, dried, cut into strips and rolled. If to be "faster," the heat is to be continued longer, according to the quickness desired. Care must be taken to avoid boiling, which might disintegrate the paper.

In preparing these papers, every precaution against fire should be taken, and their preparation in the shop or house should not be thought of. In making the solutions, etc., where heat is necessary, the water-bath should invariably be used.—Nat. Drug.

German Enterprise in Russia.—The Russian-German Messenger says that, in spite of sharp American competition, a Berlin furniture factory secured the contract to fit up the waiting rooms of 324 stations on the Siberian Railroad. The contract calls exclusively for wooden furniture—among other things, for 16,000 chairs of the same kind, tables, divans, washstands, sideboards, etc.

JUST READY.

DIES, THEIR CONSTRUCTION AND USE,

For the Modern Working of Sheet Metals.

By JOSEPH V. WOODWORTH.

Octavo. Cloth. Very Fully Illustrated. Price $3.00 Postpaid.

This book is a complete treatise on the subject and the most comprehensive and exhaustive one in existence. A book written by a practical man for practical men, and one that no diemaker, machinist, toolmaker or metal-working mechanic can afford to be without.

Dies, press fixtures and devices from the simplest to the most intricate in modern use, are shown, and their construction and use described in a clear, practical manner, so that all grades of metal-working mechanics will be able to understand thoroughly how to design, construct and use them, for the production of the endless variety of sheet-metal articles now in daily use.

Many of the dies described in this book were designed and constructed by the author personally, others under his personal supervision, while others were constructed and used in the press rooms of some of the largest sheet-metal goods establishments and machine shops in the United States. A number of the dies, press fixtures and devices, which form a part of this book, have been selected from over 150 published articles, which were contributed by the author to the columns of the "American Machinist," "Machinery" and the "Age of Steel," under his own name.

No obsolete die, press fixture or device has found a place in this book; every engraving between its covers represents the highest that has been attained in the development of each type described. The descriptions of their construction and use will enable the practical man to adapt them for facilitating, duplicating and expediting the production of sheet-metal articles at the minimum of cost and labor.

Every manager, superintendent, designer, draftsman, foreman, diemaker, machinist, toolmaker or apprentice should have this book.

JUST PUBLISHED.

HARDENING, TEMPERING, ANNEALING AND FORGING OF STEEL.

By JOSEPH V. WOODWORTH,

Author of "Dies, Their Construction and Use."

Octavo. 280 pages. 200 Illustrations. Bound in Cloth. Price $2.50.

A new work from cover to cover, treating in a clear, concise manner all modern processes for the **Heating, Annealing, Forging, Welding, Hardening and Tempering** of steel, making it a book of great practical value to metal-working mechanics in general, with special directions for the successful hardening and tempering of all steel tools used in the arts, including milling cutters, taps, thread dies, reamers, both solid and shell, hollow mills, punches and dies, and all kinds of sheet metal working tools, shear blades, saws, fine cutlery, and metal cutting tools of all description, as well as for all implements of steel, both large and small. In this work the simplest and most satisfactory hardening and tempering processes are given.

The uses to which the leading brands of steel may be adapted are concisely presented and their treatment for working under different conditions explained, also the special methods for the hardening and tempering of special brands. In connection with the above, numbers of "kinks," "ways," and "practical points" are embodied, making the volume a text book on the treatment of steel as modern demands necessitate.

A chapter devoted to the different processes of **Case-hardening is also included**, and special reference made to **the adoption of Machinery Steel for Tools** of various kinds. The illustrations show the mechanic the most up-to-date devices, machines and furnaces which contribute to the attainment of satisfactory results in this highly important branch of modern tool-making. Send for descriptive circular.

MUNN & CO., Publishers, 361 Broadway, New York.

THE

Scientific American Suppleme[nt]

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers i[n any] part of the United States or Canada. Six dol[lars a] year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, fro[m its] commencement, January 1, 1876, can be had. [Price] 10 cents each.

All the back volumes of THE SUPPLEMENT can [like]wise be supplied. Two volumes are issued ye[arly.] Price of each volume, $2.50 stitched in paper, or $[3.50] bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AM[ERI]CAN and one copy of SCIENTIFIC AMERICAN SUPPLEM[ENT,] one year, postpaid, $7.00.

A liberal discount to booksellers, news agents [and] canvassers.

MUNN & CO., Publishers, 361 Broadway, New Y[ork].

TABLE OF CONTENTS.

Scientific American

BUILDING MONTHLY

ESTABLISHED IN 1885

Appeals to the Architect and Builder	Because it illustrates the latest works of other architects and builders. Because it publishes timely articles and notes on ventilating, plumbing, legal matters, etc. Because it has interesting talks with prominent architects.
Appeals to Those About to Build	Because it publishes views of country houses of varying architectural styles and costs in all sections of the country, only illustrating those actually built. Full floor plans and descriptions are given.
Appeals to Women	Because it is filled with suggestions relative to color schemes, draperies, wall paper, furniture, painting, sculpture, etc. Many examples are illustrated. Interiors are published in every number.
Appeals to Garden Lovers	Because it contains examples of artistic gardens, from the simplest to the most elaborate formal and Italian gardens, pergolas, summer houses, fountains, etc. Even the stable is not neglected.
An American Journal for the American	Because only American country houses and buildings are published. No foreign designs are accepted.

PRICE, $2.50 PER YEAR. SAMPLE COPY, 25 CENTS.

MUNN & CO., Publishers, 361 Broadway, New York.

ARCHITECTS SHOULD SUBSCRIBE MANUFACTURERS SHOULD ADVERTISE

PATENTS In connection with the publication of the above-mentioned journal, Messrs. MUNN & COMPANY have for fifty years acted as solicitors in preparing and prosecuting applications for patents, trademarks, etc., before the Patent Office. HAND BOOK on Patents sent free on application. Patents procured through us are noticed without charge in the *Scientific American.*

MUNN & CO., Solicitors, 361 Broadway, New York City

Branch Office, WASHINGTON, D. C.